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State of Connecticut

REPORT

OF

The Connecticut Agricultural Experiment Station

FOR THE YEAR 1902

PART II

SECOND REPORT OF THE STATE ENTOMOLOGIST

W. E. BRITTON, B.S.

SECOND REPORT

OF THE

STATE ENTOMOLOGIST

OF

CONNECTICUT

FOR THE YEAR 1902

BY

W. E. BRITTON, B.S.

State Entomologist

New Haven, Conn.

1903

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SECOND REPORT

OF THE

STATE ENTOMOLOGIST OF CONNECTICUT

To the Board of Control of the Connecticut Agricultural Experiment Station:

I hereby transmit my second Report as State Entomologist under the act concerning Insect Pests. This Report is a record of entomological work during the calendar year of 1902, while the statement of receipts and expenditures is for the State fiscal year from October 1st, 1901, to September 30th, 1902.

Respectfully submitted,

W. E. BRITTON,
State Entomologist.

REPORT OF THE RECEIPTS AND EXPENDITURES OF THE STATE ENTOMOLOGIST FROM OCTOBER 1ST, 1901, TO SEPTEMBER 30TH, 1902.

RECEIPTS.

From William H. Brewer, Treasurer	$ 522.00
E. H. Jenkins, Treasurer	2,800.00
N. D. Platt for oil	2.00
	$3,324.00

EXPENDITURES.

Field, office and laboratory assistance	$ 497.97	
Printing and illustrations	1,011.60	
Postage	37.12	
Stationery	122.88	
Telephone and Telegraph	2.10	
Express, freight and cartage	25.92	
Library	305.86	
Laboratory apparatus and supplies	458.58	
Spraying apparatus and supplies	168.00	
Office supplies	93.66	
Traveling expenses of Entomologist and assistants, including nursery and orchard inspection and experimental work, meetings, etc.	600.31	
		$3,324.00

Memorandum—This account of the State Entomologist has been duly audited by the State Auditors of Public Accounts.

The Insect Pest Law.

Chapter 238, General Statutes of Connecticut.

Section 4386. State entomologist; appointment. Said board of control shall appoint a state entomologist to hold office during the pleasure of the board, who shall have an office at the experiment station, but shall receive no compensation other than his regular salary as a member of the station staff. He may appoint such number of deputies, not exceeding three, as he may deem necessary.

Sec. 4387. Duties. The state entomologist, either personally or through his deputies, shall visit any orchard, field, garden, nursery, or storehouse, on request of the owner, to advise treatment against pests. He may inspect any orchard, field, or garden, in public or private grounds, which he may know or have reason to suspect to be infested with San José scale or any serious pests; may issue such bulletins of said experiment station as in his judgment are needed to convey information about pests; may conduct experiments and investigations regarding injurious insects and the remedies for their attacks; diffuse such information by means of correspondence, lectures, and published matter; and may employ such assistants in his office, laboratory, or in the field, and purchase such apparatus and supplies as may be necessary. He shall keep a detailed account of expenses, and publish each year a report of such expenses, and of the work done.

Sec. 4388. Certificate of inspection of nursery stock. All nursery stock shipped into this state from any other state, country, or province, shall bear on each package a certificate that the contents of said package have been inspected by a state or government officer and that said contents appear free from all dangerous insects or disease. In case nursery stock is brought within the state without such a certificate, the consignee may return it to the consignor at the latter's expense, or may call the state entomologist to inspect the same and deduct the costs of such inspection from the consignor's bill for such stock. This section shall be deemed to be a part of every contract made in this state for the sale of nursery stock to be shipped into this state.

Sec. 4389. Inspection of nurseries. Penalty. All nurseries or place where nursery stock is grown, sold, or offered for sale, shall be inspected at least once each year by the state entomologist or one of his deputies, and if no serious pests are found, a certificate to that effect may be given. If such pests are found the owner shall take such measures to suppress the same as the state entomologist may prescribe. If such measures are not immediately taken by the owner of such nursery or place such certificate shall be withheld, and every nurseryman who does not hold such a certificate, after the first annual inspection, who shall sell or otherwise dispose of nursery stock, shall be fined not more than fifty dollars. The form of certificate and the season for inspecting nurseries may be determined by the state entomologist. The state entomologist or any of his deputies may at all times enter any public or private grounds in the performance of his duty.

Sec. 4390. Appropriation. The sum of three thousand dollars is appropriated to carry out the provisions of Sections 4386, 4387, 4388, and 4389, which sum is to be paid quarterly to the treasurer of said station, who shall hold the same subject to the order of the state entomologist.

Entomological Work.

The entomological work under the law has been prosecuted along the following lines during the year:

1. Increasing the collection of Connecticut insects.
2. Arranging exhibition sets showing the life-stages of injurious species.
3. Field experiments in destroying the San José scale-insect.
4. Publications.
5. Illustrated lectures.
6. Correspondence.
7. Inspection of nurseries.
8. Examination of orchards, gardens, etc., upon request.
9. Identification of insects for farmers and fruit growers.
10. A study of the white-fly.
11. Observations on the injurious and beneficial insects of the season.

Organization, Equipment, Etc.

Assistance.—Since March 1st the writer has been assisted in the office, field and laboratory by Benjamin H. Walden, B.Agr., a graduate of the Connecticut Agricultural College. Mr. Walden has also done much of the photographic work of the season. A student was employed for a few weeks to collect insects.

Equipment.—The laboratory equipment has been increased by the purchase of a specimen cabinet, breeding cages, collecting nets, a dissecting microscope, attachable mechanical stage for the compound microscope, a cabinet holding nearly 1,000 microscopic slides and a small enlarging camera. A considerable number of the Riker specimen tablets and small glass-covered wooden cases have been procured and are especially useful in exhibiting insects.

Two Gould "Kerowater" and one Deming "Peerless" barrel pumps, and several Deming "Success" bucket pumps were purchased for experimental work. These pumps were loaned to orchardists when not needed in our own experiments.

For fumigating trees a sheet tent, 24 feet square, was made of ten-ounce duck and filled with paraffine. A folding box tent for small growing trees and a box for fumigating small plants, cions, etc., were devised and constructed.

The general collection of insects has been increased nearly one-third by the season's accessions.

Library.—Important additions to the entomological library have been complete sets of the Transactions of the American Entomological Society; Psyche; Journal of the New York Entomological Society and Entomologica Americana. The accessions also include the Practical Entomologist, Miss Ormerod's English Reports, and a number of general and special works of one and two volumes each.

Exhibits.—A set of insecticides ready for use in sealed bottles, also some dry insecticide materials in exhibition jars, were shown at the meeting of the Connecticut Board of Agriculture at Norwich in December. At the same meeting were shown the life stages of several injurious species arranged in Riker specimen tablets, and in glass-covered wooden cases. Some of the insects were also exhibited at the various meetings of the Connecticut Pomological Society, and especially at the fruit-exhibit at Berlin, October 1st and 2d, and at the field meeting at the Experiment Station in November.

Field Experiments.—Field experiments to kill the San José scale by spraying were conducted at Westville, Bridgeport, and Terryville. These were not as extensive as had been planned, on account of unfavorable weather in late winter and early spring.

In November, 1902, a few large apple trees in Plainville were fumigated with hydrocyanic gas.

Publications.

The First Report of the State Entomologist (52 pages, 2 figs., XI plates) covering the period from July 1st, 1901, when the act concerning Insect Pests went into effect, until December 31st, 1901, was issued and distributed in May. This report also contains insect notes of the Station between November 1st, 1900, and January 1st, 1902. An edition of 10,750 copies was printed.

Postal Card Bulletin (not numbered with the regular series) giving brief instructions regarding immediate work against the Elm Leaf-Beetle was printed in an edition of 11,000 copies and mailed to residents of the State during July.

Bulletin 139, The Apple-Tree Tent-Caterpillar (12 pages, 3 figs., III plates) containing a general account of the insect and its prevalence in Connecticut, together with methods of combating it, was published in an edition of 11,000 copies and sent out in August.

Bulletin 140, The White-Fly or Plant-House Aleyrodes (17 pages, 5 figs., IV plates), being a somewhat detailed account of the injury, life history, and remedies, together with a technical description, was published in 10,500 copies and distributed in December.

Lectures.

During the calendar year the State Entomologist has given twelve lectures at farmers' and fruit growers' institutes, grange meetings, etc. Seven of these were illustrated with lantern slides.

Correspondence.

The correspondence of the Entomologist has increased gradually during the year. In addition to a number of packages and 75 circular letters sent out from this office, 679 letters have been written during the calendar year. A large portion of the correspondence is connected with the identification of insects and the method of treatment recommended.

Nursery Inspection and Certification.

In the Entomologist's report for last year, p. 232, is given a list of nursery firms to which certificates had been granted. A few firms which had not been known to the State Entomologist applied for inspections in the spring of the present year. The inspections were made and certificates granted until October 1st. These nurseries were again inspected in the fall.

Following are the names of nursery firms to which certificates have been granted. The number of the certificate and the date when the inspection was finished is also given. The list is believed to contain all nursery firms in the State with three exceptions—in one case a certificate was refused, and in two others the nurseries have not yet been put in condition to receive certificates. There are thirty-one names on the list and four of the nurseries were inspected twice, making a total of thirty-eight inspections for the year.

List of Nursery Firms Receiving Certificates in 1902.

Name of Firm.	Location.	Inspection Finished.	Certificate Number.
Allen, Chas. I. (2)	Terryville	Dec. 4	98
Atwater, C. W.	Collinsville	Oct. 7	71
Barnes Bros.	Yalesville	Oct. 16	78
Bishop, J. N. (2)	Plainville	Nov. 11	93
Bowditch, J. H.	Pomfret Center	Oct. 29	85
Burr & Co., C. R.	New Canaan	Oct. 8	73
Butler & Jewell Co., The	Cromwell	Dec. 30	95
Comstock & Lyon	Norwalk	Nov. 10	92
Conine, F. E.	Stratford	Oct. 10	75
Conn. Agricultural College (2)	Storrs	Nov. 13	94
Conn. Valley Orchard Co. (2)	Berlin	Dec. 31	99
Conway, W. B.	New Haven	Oct. 20	79
Dehn & Bertolf	Greenwich	Nov. 25	97
Elizabeth Park Nursery	Hartford	Oct. 15	77
Elm City Nursery Co.	New Haven	Oct. 30	86
Frey, Alois	Hartford	Nov. 3	88
Gardner, R. H.	Cromwell	Nov. 18	76
Gurney & Co., H. H.	New Canaan	Oct. 8	72
Hale, J. H.	So. Glastonbury	Oct. 25	82
Hoyt's Sons, Stephen	New Canaan	Oct. 9	74
Hunt & Co., W. W.	Hartford	Oct. 28	84
Jackson, B. A.	So. Norwalk	Nov. 5	91
Jackson, E. B.	Stamford	Oct. 26	83
Longden, C. E.	North Haven	Oct. 21	81
Norton, A. F.	New Britain	Dec. 31	100
Pierson, A. N.	Cromwell	Oct. 1	70
Platt Co., The Frank S.	New Haven	Oct. 20	80
Ryther, O. E.	Norwich	Nov. 5	90
Veitch Co., The Robert	New Haven	Nov. 1	87
Vidbourne & Co., J.	Hartford	Nov. 5	89
Wallace, W. E.	Hartford	Nov. 17	96

The form of certificate differs somewhat from that used last year to make it more nearly conform to the ideas expressed at the meeting of Official Horticultural Inspectors held at Washington, D. C., November 11, 1901, at which the writer was present. The changes consist in adding the date when the inspection was completed and in making it include all dangerously injurious insects and diseases without mentioning specifically any of them. The form used during 1902 is here given:—

No. _____ *Inspection completed* _____ *190*

THE

Connecticut Agricultural Experiment Station.

OFFICE OF STATE ENTOMOLOGIST,
NEW HAVEN, CONN.

Certificate of Inspection.

THIS IS TO CERTIFY that the stock at the nursery and premises of _____ of _____ Conn., has been carefully examined in compliance with the provisions of Chapter 122 of the Acts of the General Assembly, January Session of 1901, and that it is apparently free from dangerously injurious insects and diseases.

This certificate is invalid after _____ 190

_____ *State Entomologist.*

Condition of Nurseries in 1902.

With a few exceptions the nurseries of the State were found to be in better condition as regards the scale than in 1901, when the law went into effect.

Two or three nurserymen were somewhat careless and did not take sufficiently radical measures to exterminate the pest when it had first been discovered. Consequently considerable stock had to be destroyed in 1902. In other cases, nurseries are located in the vicinity of scale-infested orchard trees to which no remedial treatment has been applied. Such nurseries will not remain uninfested. In such places much stock must annually be destroyed and the remainder fumigated or the owner must procure grounds in a better locality. But there is no

assurance that any locality will long be free from scale. Where a nursery becomes infested by proximity to infested orchards, there is no redress for the nurseryman under the present law, which makes no provision for compelling the orchardist to fumigate, spray, or destroy his infested trees.

In thirteen nurseries no trace of the scale was found, while nineteen were found to be infested. Nurserymen are usually prompt to destroy or fumigate stock when advised by the inspector to do so, and the writer here wishes to express his appreciation of their coöperation. It is only by such cordial coöperation that the pest can be controlled.

Acreage of Connecticut Nurseries.

There are at the present time about 422 acres of growing nursery stock in Connecticut. These figures are based upon data obtained from the nurserymen, and in a few cases the estimates of the inspector. Fruit stock and all kinds of hardy ornamental plants are included.

Examination of Orchards, Fields and Gardens.

Thirty-five inspections of orchards and gardens have been made during the year, most of them at the request of the owners, but in a few cases on request of some other interested person. Several times the entomologist has responded to calls to examine city shade trees for city officials and private citizens, but in most cases the inspection referred to fruit trees in orchards or gardens.

Infested Localities.

In the beginning of 1902 the San José scale-insect was known to exist in 99 localities (see Rept. for 1901, p. 234). During the year 66 new localities have been discovered, making in all 165, including nurseries.

Identification of Insects.

Considerable time has been taken in the determination of species of insects sent to the Station by fruit-growers, farmers, etc. Some of the insects were found injuring plants, while

others were sent from a desire to learn whether or not to expect injury from them. Beneficial insects like lady-beetles are frequently mistaken for injurious species by persons not familiar with insect life. The writer received specimens of the elm leaf-beetle, *Galleruccella luteola* Müll., and the two-spotted lady-beetle, *Adalia bipunctata* Linn., from a person who had found both kinds hibernating in the house and thought them to be destroyers of carpets. While the elm leaf-beetle should be killed whenever found, it would be a mistake to destroy the two-spotted lady-beetle, which is very beneficial to agriculturists because in both the larval and adult stages it feeds upon plant lice and allied insects.

The reader will notice from the following tables that of the insects identified a large proportion are scale-insects. This naturally follows the agitation and discussion regarding the San José scale-insect, which must be considered the chief pest of the Connecticut orchard. Orchardists, therefore, are anxious to know if their trees are infested, and several have expressed to the writer their satisfaction on learning that the specimens which they had submitted proved to be some other and much less dangerous kind of scale-insect. To know about it had saved them considerable worry, and enabled them to apply a remedial treatment with intelligence.

The identification of specimens, then, is of considerable importance as is evidenced by the increasing number of specimens submitted. In case of any serious insect outbreak, or the introduction into the State of any dangerous species, if specimens are sent to this office, an investigation will be conducted at once and measures will be taken to suppress it.

Between January 1, 1902, and January 1, 1903, 171 samples of insects have been received; these are given in the following list:

INSECTS RECEIVED FOR IDENTIFICATION.

Date.	Name.	Host.	Locality.	Remarks.
1902				
Jan. 3	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	Plantsville	Twigs thoroughly infested.
" 10	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	"	Newington	Females on twigs. Egg stage.
" 13	San José Scale, *Aspidiotus perniciosus* Comst.	"	Fairfield	Twig well coated.
" 21	Tulip Tree Scale, *Lecanium tulipiferæ* Cook	Tulip Tree	Bridgeport	Twig covered.
Feb. 1	Mealy Bug, *Dactylopius citri* Risso	Coleus	Southington	Plants had been killed by the insect.
" 1	San José Scale, *Aspidiotus perniciosus* Comst.	Apple and Japan Plum	Hartford	Mostly dead.
" 1	——— ?	*Ilex crenata*	New Haven	Cocoon on plants imported from Japan.
" 6	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Cheshire	Egg stage.
" 6	——— ?	Elm	Bridgeport	Pupæ from bark.
" 6	Tulip Tree Scale, *Lecanium tulipiferæ* Cook	Tulip Tree	Hartford	Partially grown insects. Alive.
" 5	Bag Worm, *Thyridopteryx ephemeræformis* Haw.	Arbor vitæ	New Canaan	Bags containing eggs, on twigs.
" 5	Cecropia Moth, *Samia cecropia* Linn.	Maple	"	Cocoon fastened to branch.
" 5	Spider's eggs, sp.	———	"	In sacks.
	Cocoons, sp.	Maple	"	
" 8	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Hartford	On twigs. Egg stage.
" 8	San José Scale, *Aspidiotus perniciosus* Comst.	"	"	On same twigs as preceding,
" 10	San José Scale, *Aspidiotus perniciosus* Comst.	"	Bridgeport	Insects mostly dead. Trees had been treated.
" 13	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Butternut	Seymour	Bark of twigs well covered. Egg stage.
" 13	San José Scale, *Aspidiotus perniciosus* Comst.	Japan Plum	Bridgeport	Insects attacked by a fungus (*Capnodium ?*).
" 14	Cherry Scale, *Aspidiotus forbesi* Johns	Apple	Plainville	A few specimens on cions.
" 15	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear	South Norwalk	Shells of both sexes on twigs. Egg stage.
" 15	Beetle, *Hylotrupes ligneus* Fabr.	Red Cedar	Westville	Emerged from tunnels in cedar bean poles.
" 20	Katydid, *Microcentrum retinervis* Say ?	Apple	Yalesville	Eggs on cions purchased for grafting.
" 24	Purple Orange Scale, *Mytilaspis citricola* Pack.	Orange	Bozrahville	On fruit purchased in market.
" 27	Beetle, *Hylotrupes ligneus* Fabr.	Red Cedar	Westville	Additional material sent by request.
Mar. 4	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear	Shelton	Egg stage.
" 13	" " "	"	New Haven	" "
" 15	——— *Aspidiotus* sp. ?	"	New London	Immature females.
" 17	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Lilac	Bridgeport	Egg stage.
" 17	" " " "	"	Meriden	" "
" 17	San José Scale, *Aspidiotus perniciosus* Comst.	Apple, Pear, Plum	Bridgeport	Insects attacked by a fungus (*Capnodium ?*).

Date.	Name.	Host.	Locality.	Remarks.
Mar. 17	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Leete's Island	Egg stage.
" 17	Mite, ——— sp. ?	Spinach	Ansonia	Eggs and adults present.
" 19	San José Scale, *Aspidiotus perniciosus* Comst.	*Spiræa Sorbifolia*	Hartford	Sent to have effect of treatment ascertained.
" 19	——— *Calophya flaveola* Riley, MS.	Sumac (*R. glabra*)	"	Pupa stage on twigs.
" 22	White-marked Tussock Moth, *Notolophus leucostigma* S. & A.	Apple	Bridgeport	Egg-mass on leaf.
" 24	Elm Leaf-Beetle, *Gallerucella luteola* Müll.		Southbury	Found hibernating in a dwelling house.
" 24	Two-Spotted Lady-Beetle, *Adalia bipunctata* Linn.		"	" " " "
" 26	San José Scale, *Aspidiotus perniciosus* Comst.	Peach	Groton	Owner had 500 trees. 25 per cent. killed.
" 27	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Bristol	On twigs. Egg stage.
" 27	" " "	Apple and Hawthorn	New Haven	" " " "
" 29	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Apple	Shaker Station	" " " "
Apr. 1	" " " "	"	Thompsonville	" " " "
" 1	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	"	"	" " " "
" 1	" " "	"	Scitico	" " " "
" 7	" " "	"	Franklin	" " " "
" 9	San José Scale, *Aspidiotus perniciosus* Comst.	Peach	Bridgeport	Twigs well covered. Mostly alive.
" 15	" " "	Apple	Unionville	Trees purchased in 1901.
" 15	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Willow	Somers	Egg stage.
" 17	Snowy Tree Cricket, *Œcanthus niveus* Harr.	Raspberry	Westville	Eggs laid in canes.
" 18	Scurfy Bark-Louse, *Chionapsis furfurus* Fitch	Currant	Highwood	Egg stage. Cane completely covered.
" 21	Promethea Moth, *Attacus promethea* Dru.	Japan Plum	Farmington	Cocoons on twigs.
" 22	San José Scale, *Aspidiotus perniciosus* Comst.	"	Meriden	Branch thickly coated.
"	" " "	Apple	Milford	Sprayed with kerosene. Not all dead.
" 23	Rose Scale, *Aulacaspis rosæ* Sand.	Rose	Clintonville	A few living insects on twigs.
" 24	Snowy Tree Cricket, *Œcanthus niveus* Harr.	Apple and Raspberry	Collinsville	Eggs deposited in the twigs.
" 24	San José Scale, *Aspidiotus perniciosus* Comst.	Plum	Highland, N. J.	A few dead specimens around buds.
" 26	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Seymour	Egg stage.
May 1	San José Scale, *Aspidiotus perniciosus* Comst.	Pear & Apple	Highwood	Partially grown.
" 1	Spider's eggs	Horse Chestnut	Morris	Egg-mass under loose bark.

Date.		Name.	Host.	Locality.	Remarks.
May	1	—— *Acronycta Americana* Harr.	Horse Chestnut	Morris	Pupa stage under the bark.
"	2	Bag Worm, *Thyridopteryx ephemeræformis* Haw.?	Cedar	New Haven	Larva on stock imported from Japan.
"	8	—— *Anomala binotata* Gyll.	Strawberry	"	Adults feeding on leaves.
"	9	San José Scale, *Aspidiotus perniciosus* Comst.	Hawthorn	"	Received from N. J. All dead.
"	12	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Lilac	West Suffield	Egg stage.
"	13	San José Scale, *Aspidiotus perniciosus* Comst.	Currant	Preston	Twig dead. Coated with scales.
"	14	Spruce Louse, *Lachnus abietis* Fitch?	Spruce	New Haven	Twig completely covered.
"	17	—— *Harpalus pennsylvanicus* DeG.		Scotland	Found around base of peach trees.
"	17	—— *Platynus placidus* Say		"	" " "
"	17	Well-marked Cut-Worm, *Noctua clandestina* Harr.		"	" " "
"	19	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	North Guilford	Eggs just hatching.
"	20	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Ash	Ansonia	Old shells only.
"	20	Beetle, *Corymbites cylindriformis* Hbst.		Warehouse Point	Found crawling upon fruit trees.
"	20	Aphis, sp.?	Plum	Newtown	On new growth.
"	20	Tortoise Beetle, *Coptocycla guttata* Oliv.	Apple and Plum	New Haven	Resting on leaves and branches.
"	20	" " " *aurichalcea* Fabr.	Apple and Plum	"	" " "
"	21	Raspberry Cane Maggot, *Phorbia rubivora* Coq.	Raspberry	Bristol	Larva tunneling in new shoots.
"	21	Abbot Sphinx, *Thyreus abbotii* Swains		Surry, N. H.	Adult.
"	22	White-marked Tussock Moth, *Notolophus leucostigma* S. & A.	Maple	Morris	Egg-masses on bark.
"	27	Forest Tent-Caterpillar, *Clisiocampa disstria* Hbn.	"	Cornwall Bridge	Larval stage, two-thirds grown.
"	27	Pine Scale, *Chionaspis pinifoliæ* Fitch	Pine	So. Manchester	Eggs just hatched.
"	27	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Lilac	" "	Old shells only.
"	31	Scale on fern, *Lecanium hemisphæricum* Targ.-Tozz?	Fern	New Britain	Specimens immature.
"	31	Forest Tent-Caterpillar, *Clisiocampa disstria* Hbn.	Maple	Hartford	Larvæ three-fourths grown.
June	2	Putnam's Scale, *Aspidiotus ancylus* Putn.	Currant	Ansonia	Mostly dead.
"	3	Strawberry Saw-fly, *Emphytus maculatus* Norton	Strawberry	East Wallingford	Larvæ, partially grown.
"	3	Eight-spotted Forester, *Alypia octomaculata* Hbn.		New Haven	Adult moth.
"	3	Currant Aphis, *Myzus ribis* Linn.	Currant	Milford	Under side of leaves covered.

Date.	Name.	Host.	Locality.	Remarks.
June 3	Four-lined Leaf-bug, *Pœcilocapsus lineatus* Fabr.	Sage and *Œnothera*	Milford	Sucking sap from the leaves.
" 4	Twice-stabbed Lady Beetle, *Chilocorus bivulnerus* Muls.	San José Scale	Stratford	Abundant and devouring the scales.
" 5	Scale, *Lecanium juglandis* Bouché?	Plum	Watertown	Only one individual.
" 6	" " "	"	West Haven	Egg stage. Twig well infested.
" 6	Scarlet Spider, *Trombidium sericeum* Say		Rainbow	Found upon seedling pines.
" 9	Abbot Sphinx, *Thyreus abbotii* Swains		Hartford	Adult moth.
" 9	Oyster-shell Bark-Louse, *Mytilaspis pomorum* Bouché	Willow	New London	Newly hatched insects, crawling.
" 11	Quince Curculio, *Conotrachelus crataegi* Walsh	Quince	Woodbridge	Work of insect in young fruit.
" 16	Tulip Tree Scale, *Lecanium tulipiferæ* Cook.	Tulip Tree	Brookfi'ld Center	Both sexes on twigs.
" 18	Eyed Elater, *Alaus oculatus* Linn.		Woodbridge	Adult beetle.
" 24	Moth, *Noctua lubricans* Gn.		Farmington	Adults found in buildings.
" 25	Lady Beetle, *Brachyacantha ursina* Fabr.		Hartford	Devouring plant lice on plum tree.
" 27	Strawberry Leaf-Roller, *Phoxopteris comptana* Frol.	Strawberry	Collinsville	Larvæ badly crushed.
" 28	Cherry Aphis, *Myzus cerasi* Fabr.	Cherry	Cannon	Causing leaves to curl.
" 28	Black Aphis, sp.?	Windsor Bean	New Haven	Leaves and stems covered.
" 28	Tortoise Beetle, *Coptocycla clavata* Fabr.	Tomato	Warren	Adults devouring leaves.
July 5	Ambrosia Beetle, *Xyleborus pyri* Peck	Peach	Long Hill, Middletown	Adults emerging from tunnels in trunk.
" 9	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Westport	Both sexes present.
" 12	Fruit Bark Beetle, *Scolytus rugulosus* Ratz.	Plum	New Haven	Burrowing in trunk and branches.
" 14	Tulip Tree Scale, *Lecanium tulipiferæ* Cook.	Magnolia	"	Both sexes present.
" 14	Mealy Bug, *Dactylopius citri* Risso	"	"	On twigs with *L. tulipiferæ*.
" 17	Saw-fly, *Selandria*, sp.?	Hawthorn	Southington	Larvæ eating green portion of leaves.
" 18	Broad-necked Prionus, *Prionus laticollis* Dru.		New Milford	Adult beetle.
" 18	Lesser Prionus, *Orthosoma brunneum* Forst.		"	" "
" 18	Brown Elaterid, sp.?		"	" "
" 18	White-fly, *Aleyrodes vaporariorum* Westw.	Strawberry	Milford	Both larvæ and adults present.
" 21	Cabbage Aphis, *Aphis brassicæ* Linn.	Turnip & Kale	"	On seed plants.
" 22	Caterpillar, sp.?	Gloxinia	Bristol	Eating flowers and leaves.
" 22	Maple Borer, *Plagionotus speciosus* Say	Maple	"	Found on trees.
" 23	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Pear	Rockville	Both sexes present.
" 28	Cranberry Worm, *Rhopobota vacciniana* Pack.	Cranberry	"	Adult insects.

Date.		Name.	Host.	Locality.	Remarks.
July	29	Apple Leaf-Miner, *Tischeria malifoliella* Clem.	Apple	Quaker Hill	Larvæ mining in apple leaves.
"	31	White-Fly, *Aleyrodes vaporariorum* Westw.	Strawberry	Saugatuck	Larvæ and adults present.
Aug.	1	Fruit Bark-Beetle, *Scolytus rugulosus* Ratz.	Peach	Stamford	Boring in trunk.
"	1	Ichneumon Fly, *Thalessa*, sp.?		New Haven	Issuing from dead tree.
"	11	Tulip Tree Scale, *Lecanium tulipiferæ* Cook	Tulip Tree	Danbury	Not fully mature.
"	14	" " " "	"	Southington	" "
"	14	—— *Alaria florida* Gn.		New Haven	Found on flowers.
"	14	Strawberry Flea Beetle, *Haltica ignita* Ill.	Elm & Hickory	Chapinville	Small dark-blue beetles feeding on leaves.
"	16	Saw-fly, *Selandria*, sp.?	Cherry	Harwinton	Larvæ eating leaves.
"	18	Saddle-Back Caterpillar, *Empretia stimulea* Clem.	Pear	Mt. Carmel Center	" " "
"	18	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Hartford	
"	19	Tomato Worm, *Protoparce Carolina* Linn.	Tomato	New Haven	Small larva parasitized.
"	20	Spider, *Lycosa scutellata*		Hartford	
"	20	Cecropia Caterpillar, *Samia cecropia* Linn.	Chestnut	New Haven	Larva devouring leaves.
"	21	Asparagus Beetle, *Crioceris asparagi* Linn.	Asparagus	Shelton	Devouring asparagus plants.
"	21	Orange-striped Oak Worm, *Anisota senatoria* S. & A.	Oak	New Haven	Larvæ stripping the trees.
"	23	Yellow-necked Caterpillar, *Datana ministra* Dru.	Apple	Burlington	
"	23	Raspberry Moth, *Synchlora glaucaria* Gn.		New Canaan	Adult insect.
"	23	White Pine Weevil, *Pissodes strobi* Peck	White Pine	New Haven	Pupæ and adults from the leader of a young pine.
"	23	Walking Stick, *Diapheromera femorata* Say		"	Found inside of a building.
Sept.	4	Dog-day Harvest Fly, *Cicada tibicen* Linn.		Hockanum	One adult and several pupa cases.
"	4	Red Humped Caterpillar, *Œdemasia concinna* S. & H.	Japan Plum	Forestville	Larvæ devouring foliage.
"	4	Slug Caterpillar, *Parasa chloris* H.-S.	"	"	" " "
"	5	" " *Lagoa crispata* Pack.	Quince	New Haven	" " "
"	8	Pine Saw-fly, *Lophyrus*, sp.?	Pine	Rainbow	Larvæ, yellow with black spots. Pupated in a few days.
"	13	Cecropia Caterpillar, *Samia cecropia* Linn.	Plum	New Haven	Parasitized larva eating leaves.
"	13	Luna Caterpillar, *Actias luna* Linn.	Chestnut	"	Larva eating leaves.
"	15	San José Scale, *Aspidiotus perniciosus* Comst.	Apple & Pear	"	Dead insects on dead wood. Many trees killed.
"	15	" " "	Peach	Southport	A few young scales around the buds.
"	19	Tomato Worm, *Protoparce Carolina* Linn.	Lilac	New Haven	Larva.
"	20	Slug Caterpillar, *Lagoa crispata* Pack.	Apple	"	Larva eating leaves.

Date.	Name.	Host.	Locality.	Remarks.
Sept. 20	Saddle-Back Caterpillar, *Empretia stimulea* Clem.	Honeysuckle	New Haven	Larva eating leaves.
" 22	Cabbage Aphis, *Aphis brassicæ* Linn.	Cabbage	Milford	On leaves, sucking the sap.
" 29	San José Scale, *Aspidiotus perniciosus* Comst.	Peach and *Cornus*	New Haven	Mature females and young.
Oct. 14	Pigeon Tremex, *Tremex Columba* Linn.	Hickory	"	
" 24	—— *Sesia*, sp.?	"	Stockbridge, Mass.	Galls on twigs.
" 30	San José Scale, *Aspidiotus perniciosus* Comst.	Plum, Apple, Pear & Peach	Meriden	Twigs completely encrusted.
Nov. 10	Tulip Tree Scale, *Lecanium tulipiferæ* Cook	Tulip Tree	New Haven	Old shells and immature insects.
" 11	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	Shaker Station	Twig badly infested. Young crawling.
" 14	White-Fly, *Aleyrodes vaporariorum* Westw.	Geranium	New Haven	Larvæ and adults on under surface of leaves.
" 15	Lady Beetle, *Pentilia misella* LeC.	San José Scale	Westville	Reported as being very abundant on infested plum tree.
" 17	San José Scale, *Aspidiotus perniciosus* Comst.	Apple	Baltimore, Md. Sent from New Canaan	All dead; had been fumigated.
" 21	Rose Scale, *Aulacaspis rosæ* Sand.	Rose	Danielson	Males and females. Egg stage not found.
" 24	Spider, sp.?		New Haven	Found in cellar.
" 24	San José Scale, *Aspidiotus perniciosus* Comst.	Plum	Geneva, N. Y. Sent from New Canaan	Dead; had been fumigated.
" 28	" " "	"	Cromwell	" " "
Dec. 2	Scurfy Bark-Louse, *Chionaspis furfurus* Fitch	Apple	Bridgeport	Mostly dead. Had been treated.
" 4	San José Scale, *Aspidiotus perniciosus* Comst.	"	East Hartford	Egg stage.
" 6	White-Fly, *Aleyrodes vaporariorum* Westw.	*Fuchsia* and *Eupatorium*	Pomfret Center	On trees purchased in 1901.
" 16	Spider, *Agalena nævia*		Levis, Quebec, Canada	Adults only.
" 26	Apple Aphis, probably, *Aphis pomi* DeG.	Apple	Hartford	Eggs glued around the buds.
" 26	—— sp.?	"	Collinsville	A larva making sinuous burrows just beneath the outside layer of cells of the bark of twigs.

EXPERIMENTS IN SPRAYING TO KILL THE SAN JOSÉ SCALE-INSECT. SEASON OF 1902.

Spraying experiments to kill the San José scale-insect were conducted in three different places, Westville, Bridgeport and Terryville. On account of stormy and windy days through March the spraying was mostly delayed until the month of April. The leaves soon began to appear, so that the time for applying insecticides to dormant trees was comparatively short. The experiments, therefore, were much less extensive than had been planned.

In each of the experiments, as in those of 1901, twigs were examined just before spraying, and the percentages of living scales noted. About six weeks after spraying, twigs were again examined to ascertain the effect of the treatment. Thirty trees in Westville, 11 in Terryville, and over 200 in Bridgeport were treated in the experiment.

The insecticides used were: crude oil undiluted and in 25 per cent. mixture with water; kerosene, 25 per cent. mixture in water; Adler's soda soap, one pound in one gallon of water; "Naphcin," one-half pint in two gallons of water, and the lime, sulphur and salt mixture.

Three kinds of crude oil were used:

Standard Oil Co., testing 43° Beaumé; Derrick Oil Co., testing 45° Beaumé; a black oil, purchased near Terryville, 35.8° Beaumé.

The lime, sulphur and salt mixture was prepared after two formulas, as follows:

No. 1	50 lbs.	Fresh stone lime.
	50 "	Flowers of Sulphur.
	50 "	Common salt.
	150 gals.	Water.
No. 2	30 lbs.	Fresh stone lime.
	20 "	Flowers of Sulphur.
	15 "	Common salt.
	60 gals.	Water.

In each case the materials were weighed out, the lime slaked, the sulphur and salt added with enough water to cover and the whole boiled in a kettle for at least one hour. The water was

then added and the mixture applied while fresh. Boiling for a longer time is said to improve the mixture and some recommend boiling it for three hours, but this was not done in these experiments.

Westville Experiments.

Sixteen young pear trees were sprayed, March 24th, with 25 per cent. crude oil (Standard Oil Co.) in water. These trees were badly infested and were cut back previous to spraying. On April 1st six trees (five pear and one plum) were sprayed: three pears with 25 per cent. kerosene in water; one pear with lime, sulphur and salt mixture, and a pear and a plum each were drenched with undiluted crude oil. Eight trees were sprayed April 15th. Undiluted crude oil (Standard Oil Co.) was applied to two apple, one cherry and one plum tree. One pear was treated with undiluted Derrick oil, and another with the same kind of oil used in 25 per cent. mixture with water. One pear tree was sprayed with Adler's soda soap, one pound in one gallon of water, and one tree with the lime, sulphur and salt mixture. The spraying was done in favorable weather and the trunk, branches and twigs were coated with the liquid as thoroughly as it was possible to coat them.

By consulting Table I, page 116, the reader will see that on a number of young pear trees sprayed with 25 per cent. crude oil and 25 per cent. kerosene, no living insects could be found on May 23d. These were all small trees where it was possible to reach all twigs with the bamboo extension from the ground.

The two apple trees sprayed April 15th (see Table II) were large trees and ladders were used in spraying. The fact that 13 per cent. of living insects were found indicates that these trees were not as thoroughly covered with the spray as some others. These trees were severely injured, presumably by the oil. Some injury was caused by both the Standard and Derrick oils where used undiluted, with very slight injury from each in 25 per cent. mixtures with water. No injury could be detected from the use of the lime, sulphur and salt mixture.

Experiments at Bridgeport.

Between April 10 and April 16 over 200 trees were sprayed in this experiment. Nearly all were Japan plum of medium

TABLE I.—WESTVILLE EXPERIMENTS. DORMANT TREES SPRAYED MARCH 24, 1902.

Number of trees treated.	Kind of trees.	Condition of trees before treatment.	Treatment and materials applied.	Per cent. of living insects at time of treatment.	Per cent. of living insects on May 23.	Per cent. probably killed by treatment.	Effect of treatment on trees.
10	Pear	Badly infested	25 per cent. crude oil in water	85.4	.09	85.3	Slight injury.
1	"	" "	" " " " "	75.5	0	75.5	" "
1	"	" "	" " " " "	63.	0	63.	" "
1	"	" "	" " " " "	53.4	0	53.4	" "
1	"	" "	" " " " "	52	0	52.	" "
1	"	" "	" " " " "	77	0	77.	
1	"	" "	" " " " "	41	†	--	

WESTVILLE EXPERIMENTS. DORMANT TREES SPRAYED APRIL 1, 1902.

1	Pear	Badly infested	25 per cent. kerosene in water	62	0	62	No injury.
1	"	" "	" " " "	75	0	75	" "
1	"	" "	" " " "	90	0	90	Buds slightly injured.
1	"	" "	Crude oil, drenched	84	0	84	Buds nearly all killed.
1	Europ. Plum	" "	" " "	72.2	0	72.2	" " " "
1	Pear	" "	Lime sulphur salt*	95	.05	94.9	No injury.

* Formula No. 1.

† This tree was removed by the owner before a record was taken.

TABLE II.—WESTVILLE EXPERIMENTS. DORMANT TREES SPRAYED APRIL 15, 1902.

Number of trees treated.	Kind of trees.	Condition of trees before treatment.	Treatment and materials applied.	Per cent. of living insects at time of treatment.	Per cent. of living insects on May 23.	Per cent. probably killed by treatment.	Effect of treatment on trees.
1	Apple	Badly infested	Crude oil (Standard)	46	13	33	Nearly all buds killed.
1	Cherry	Moderately infested	" " "	21.2	0	21.2	" " " "
1	Elm	" "	" " "	32	0	32	Buds nearly all killed.
1	Pear	Badly infested	Derrick oil	50.4	0	50.4	Buds considerably injured.
1	"	" "	Derrick oil, 25%	65.4	0	65.4	Very slight injury.
1	"	" "	Soda soap, 1 lb. 1 gal.	62.	18	44	No injury.
1	"	" "	Lime sulphur salt*	71	.03	70.07	" "

* Formula No. 1.

TABLE III.—BRIDGEPORT EXPERIMENTS. DORMANT TREES SPRAYED APRIL 10–16, 1902.

Number of trees treated.	Kind of trees.	Condition of trees before treatment.	Treatment and materials applied.	Per cent. of living insects at time of treatment.	Per cent. of living insects June 23.	Per cent. probably killed by treatment.	Effect of treatment on trees.
71	Japan Plum	Badly infested	25 per cent. crude oil in water	43	.08	42.92	No injury.
30	Japan Plum	" "	" " "	79	4.9	74.1	No injury.
30	Japan Plum	" "	" " "	83	9.5	73.5	No injury.
1	Cherry	Moderately infested	" " "	71.1	2.1	69.1	No injury.
1	Cherry	" "	Lime, sulphur, salt*	85.6	†	----	No injury.
1	Peach	" "	" " "	56	0	56.	No injury.

* Formula No. 1. † The record was accidentally destroyed so that an exact percentage cannot be given, but it was very small.

TABLE IV.—TERRYVILLE EXPERIMENTS. DORMANT TREES SPRAYED APRIL 18, 1902.

Number of trees treated.	Kind of trees.	Condition of trees before treatment.	Treatment and materials applied.	Per cent. of living insects at time of treatment.	Per cent. of living insects June 24.	Per cent. probably killed by treatment.	Effect of treatment on trees.
1	Plum	Moderately infested	Lime, sulphur and salt*	58	7.3	50.7	No injury.
1	"	" "	" " "	62	.89	61.11	No injury.
1	"	Badly "	" " "	42	5.5	36.5	No injury.
1	"	" "	" " "	60.2	4.5	55.7	No injury.
1	"	" "	" " "	74	0	74.	No injury.
1	"	" "	" " "	57	5.3	51.7	No injury.
1	Peach	Moderately "	" " "	98	.063	97.93	No injury.
1	Plum	Badly "	Naphcin, ½ pint to 2 gall.	69.5	37.8	31.7	No injury.
1	"	" "	" " "	66	38.	28.	No injury.
1	"	" "	25 per cent. crude oil in water	61	0	61.	Considerable injury.
1	"	" "	" " "	54	0	54.	Considerable injury.

* Formula No. 2.

size, planted close together and badly infested. Though only 134 trees are recorded in Table III, many more were treated from which no twigs were taken. The oil used was from the Standard Oil Co., and in 25 per cent. mixture with water, seemed to cause no injury to the trees. On the other hand, the percentage of living insects after the treatment was somewhat greater than the average in the Westville experiment, where similar methods were used.

Terryville Experiments.

On April 18th ten Japan plum and one peach tree were sprayed at Terryville. The lime, sulphur and salt was used on six plum and one peach tree and in no case did it appear to injure the tree. It was quite effective, moreover, in destroying the scales. The crude oil used here was a very heavy, black oil, testing 35.8° Beaumé, and purchased in the vicinity. It injured the trees to some extent. The "Naphcin," a commercial preparation much advertised, did not prove very deadly to the scales, as the figures of Table IV show.

Other Records.

The most extensive test of the lime, sulphur and salt was made at Yalesville by Barnes Bros., who sprayed 7,000 trees or nearly half their orchard with the mixture just before the buds started in spring. Formula 2, as given on page 114, was used in the Barnes orchard, but instead of diluting after boiling, the whole volume of water was boiled with the other ingredients for two hours instead of one hour, as was practiced in our experiments. The Messrs. Barnes employed a steam boiler of about five horse power capacity, and on two sides of the boiler were placed eight 120-gallon hogsheads to hold the mixture and into which the steam was forced through iron pipes connected with the boiler. The cooking apparatus shown on plate III was placed by a spring near one side of the orchard so that an abundance of water could be easily obtained. Many practical difficulties were encountered that hindered the work and increased the cost of it. It was found that leather packing in the pumps was soon destroyed as well as leather shoes and gloves worn by the workmen. The mixture corrodes the skin, making the face and hands sore after working in it for a few

days, so that some protection is necessary. The cost of the application was about eleven cents per tree including cost of boiler and apparatus, materials, labor, etc., but the boiler has not been injured and its cost should not be charged wholly to one season's account. Boiling the whole quantity of the mixture for so long a time also greatly increased the cost per tree.

In some laboratory tests made at the Station it was found that flowers of sulphur being in smaller particles dissolves up quicker than the sulphur flour or ground brimstone. In preparing the mixture after formula No. 2, all the flowers of sulphur dissolved on boiling for one hour, but where the sulphur flour was used some undissolved sulphur remained after boiling the same time. It will probably pay to screen the sulphur just before boiling to get rid of all lumps that do not dissolve readily in making the mixture.

The writer went through the orchard in July and again in August and observed the result of the work. Only a few living insects could be found, showing that the insecticide was effective, and the trees appeared clean and healthy. The owners are well satisfied with the results of the treatment and feel sure that the injury caused by peach scab and brown rot were somewhat lessened by it. The remaining portion of their orchard will be sprayed the coming season. It should be noted that the lime, sulphur, and salt mixture is probably an excellent fungicide as well as insecticide. Sulphide of potassium is often applied to combat fungus diseases and there is no reason why sulphide of lime, the effective agent in lime, sulphur, and salt, should not be equally effective and more lasting in its effects.

The use of a *more dilute* solution of sulphide of lime on trees in foliage for the destruction of fungi is well worth testing.

A grower near Bridgeport used the mixture quite extensively the past season and reports satisfactory results. An orchardist in Milford who sprayed many peach trees, using both crude oil and the lime, sulphur, and salt mixture, reports that the latter proved far more satisfactory.

Oil was also used by many orchardists and satisfactory results were obtained in most cases. Some applied it undiluted through a nozzle having a small aperture, and others used it in 25 per cent. mixture with water. Both kerosene and crude oil were employed.

The extensive spraying operations in Keney Park, Hartford, were under the direction of Mr. H. J. Koehler, who kindly furnishes the following notes:

"Our spraying for the San José scale-insect was done during the months of January, February, March and April. The materials used were as follows: whale oil soap, of three different brands, all supposed to be made of potash instead of soda, crude petroleum, kerosene, and the lime, sulphur, and salt wash made after the formula given by the Department of Agriculture. (See formula No. 2, page 114.)

The greater part of the whale oil soap was dissolved in hot water at the rate of two pounds of the former to one gallon of the latter, and the rest at the rate of one and one-half pounds to one gallon of water, the manufacturer of one brand recommending this proportion. The directions for use which accompany the soaps often state that they can be dissolved in cold water, but we found this impossible after several attempts. Possibly in the summer, with the water warmer than in winter, it might be done, although it is doubtful. One brand proved refractory even with boiling water, and a barrel full of the dissolved mixture left standing over night was so hard the next morning that it could almost be cut, and had to be heated over again before using. The other two brands when once dissolved could be used without difficulty even when ice cold. For heating purposes we used a sixty gallon iron kettle, set into an iron ring supported by five legs. This was set up out of doors, and sheet iron was used to confine the fire, an opening being left to secure draft. One man was kept constantly at the kettle, his time being occupied in weighing soap, getting water, splitting wood for the fire, etc.

The crude petroleum was ordered from the Providence Department of the Standard Oil Company, Providence, R. I. We tested it and found it to be of the required specific gravity, that is between 43° and 45° Beaumé. The cost of the petroleum was ten cents a gallon, including barrel, shipping charges extra. It was applied undiluted.

The refined kerosene was ordered from a local dealer, and the same as is used for illuminating purposes. The barrels were marked '150 Water White Oil.' It was applied in the form of a mechanical mixture with water, most of it with the pump set at twenty-five per cent. We found it impossible to maintain the percentage accurately. It was usually greater than that indicated. In testing it without a nozzle so that no pressure accumulated in the pump it worked quite accurately, but soon after attaching the nozzle pressure would accumulate and the accuracy would be impaired. Possibly the proportion of accumulated compressed air in the air pump was greater than that in the oil pump, and therefore not enough water was pumped per stroke. Attempts were made to get the desired percentage by setting the pump at a lower percentage than what was wanted. This scheme did not work on account of the varying pressure in the pump, so it is safe to say that we tried all percentages between ten and fifty, the average being probably about twenty-five.

On account of the amount of spraying we had to do, it was impossible to wait until the weather conditions were ideal for the use of kerosene and crude petroleum. It might be fine in the morning at the time of starting out, and then change. Unless it actually began to rain we usually kept right on, until quitting time, which was then 4.30 P. M.

We sprayed an old orchard, consisting mostly of apples and a few pears, with twenty-five per cent. kerosene, on a day when the sky was uniformly overcast and which during part of the time was foggy. Up to date (June 19th), no injury is apparent, in fact no injury to any thing has yet been noticed where the oil and water mixture was used. Considerable injury was done with the crude oil. A number of peach trees and *Cornus florida* were killed outright, and most, although not all, the plants sprayed with crude oil seemed to be retarded in their growth, so that they have not even yet caught up with plants sprayed with other materials. The peach trees were sprayed in the afternoon of a fairly bright still day which came in between two rainy days, with snow on the ground, so that there must have been considerable moisture in the air. The other plants were sprayed on an ideal day, that is, clear and windy. It may be said that all of the plants on which crude oil was used, were quite thoroughly drenched. To merely moisten the plants as prescribed was in our experience an impossibility with the pump. The only way we could do this was by making the application with a 'Cyclone Bug Exterminator,' a syringe made on the plan of an atomizer, and which gives the finest possible spray. Crude oil applied with this syringe was used on one peach tree about twelve feet high, and the tree given a thin film of oil all over. The difference in favor of this tree and those sprayed with the pump was quite marked, even where such trees showed no effect of the oil except a retardation of growth. In fact it seemed to me that this tree started out more vigorously than unsprayed ones. The application was made on a bright still day, about two o'clock in the afternoon. A friend of mine sprayed an elm in full leaf in June with pure kerosene with one of these syringes and no injury resulted.

The variety of plants sprayed was quite extensive. Some of those sprayed with kerosene and water were: *Aronia nigra, Rosa blanda, lucida, Carolina, multiflora* and *rugosa, Viburnum Opulus* and *dentatum, Cornus stolonifera, sericea, paniculata, florida,* and *alternifolia, Pyrus Aucuparia* and *baccata, Prunus maritima, serotina, Virginiana,* and *pumila, Crataegus Crus-Galli, coccinea, cordata,* and *Oxyacantha,* peaches. pears, apples, plums, cherries, and currants. Just to note the effect, *Pinus Strobus, Tsuga Canadensis, Picea excelsa,* and *Kalmia latifolia* were sprayed with oil and water with the pump set at twenty per cent. and some with whale oil soap. No injury resulted in either case. Some of the above mentioned conifers were sprayed with crude oil. All were considerably retarded, although none seem to have been killed.

When applying the lime, sulphur, and salt wash, care was taken to keep it well agitated. The application was followed by several dry days, and later pouring rains had no visible effect in washing it off. Even weeks

afterwards the plants looked as white as at the time they first became dry after the spraying, and the smell of sulphur was still noticeable.

Nevertheless, even if it proves a reliable insecticide, it is hardly to be recommended for extensive use on landscape plantings on account of the ugly whiteness which it imparts. It is the cheapest of all materials, and objections against its use on aesthetic grounds would have little weight on commercial places."

Discussion of Results.

From these experiments it appears that the undiluted crude oil is liable to cause injury to some trees even if applied under favorable conditions and with considerable care. Ought we then to advise it where unskilled workmen must necessarily apply it to the trees? In some other states, notably Ohio, very great damage has resulted from the extensive spraying of orchards with oils. In case of a badly infested tree it is rather difficult to decide whether the injury was caused by the application or whether the scale was largely responsible for it.

There is much less danger of injuring the trees where the oil is applied in a 25 per cent. mixture with water, but the pumps for mixing have not yet been perfected, and do not always give the proper proportions. The operators are also subjected to many annoyances from the clogging of the oil or water valves or some other disorder of the pump. Crude oil and kerosene, either undiluted or in 25 per cent. mixture, will kill the scale-insects if it comes in contact with them, and coat the surface reaching into the crevices of the bark much better than most liquids. This merit is of considerable importance. Hundreds of trees have been sprayed with oils without apparent injury. But occasionally serious injury has occurred with no apparent reason.

To reduce the danger to a minimum the oils should be applied on bright days in early spring just before the buds open. Growth then begins at once. If applied in late fall or early winter there is a long period of inactivity of the tree, during which the oil may penetrate and injure the cambium. The relatively short period of application at a time when the season brings a rush of work, and many windy days when spraying is impossible, is a disadvantage for the oil treatment.

In a single season's experiments the lime, sulphur, and salt mixture has destroyed the insect as effectively as the oil and no

trees have been injured. No record of injury has yet come to my notice where this mixture was used on dormant trees in Connecticut or any other state. It can be applied with any spraying pump, thus obviating the difficulties connected with the oil and water pumps. The mixture may be applied at any time during the winter months, making the spraying season much longer so that suitable days may be selected for spraying and allowing time to finish the work before the rush of the spring season comes. The materials are not costly, but the boiling of them is something of a nuisance, and is the greatest disadvantage of the lime, sulphur, and salt mixture. On a small scale the materials may be boiled in a kettle, but in a large orchard, the best method is to boil them in barrels with live steam from a boiler, as described on page 120, and shown on plate III.

Summary.

1. Spraying experiments were conducted in Westville, Bridgeport and Terryville during March and April, 1902, about 250 trees in all being treated. Most of the trees were badly infested.

2. Three kinds of crude oil, each used in 25 per cent. mixture with water, and two kinds used undiluted; kerosene, 25 per cent. mixed with water; Adler's soda soap, one pound in one gallon of water; "Naphcin," one-half pint in two gallons of water; and the lime, sulphur, and salt mixture made up after two formulas, were the insecticides used.

3. The crude oils, both undiluted and in 25 per cent. mixture, were effective in killing the scales, but damaged the trees in some cases. At Bridgeport almost no injury could be detected. Twenty-five per cent. kerosene in water was also fatal to the insects and caused only slight injury to the trees.

4. Adler's soda soap and "Naphcin," in the proportions used were not effective in killing the scales, though perhaps might be in more concentrated preparations. The trees were not injured.

5. Lime, sulphur and salt, in both of the formulas used, destroyed the scales satisfactorily without injuring the trees, and has been employed extensively in some of the large peach orchards with satisfactory results.

The admirable work done by Barnes Bros. shows that large bearing orchards can be sprayed effectively with this mixture at a cost of not more than eleven cents per tree.

FUMIGATION EXPERIMENTS.

During November, 1902, it was discovered that three large apple trees at Plainville were infested with the San José scale-insect.

The owner naturally wished to save the trees, as he had no others bearing the same varieties of apples, and was anxious to fumigate them, though was willing to destroy them if advised to do so.

A fumigating cloth or sheet tent was procured in the spring, made of ten-ounce duck and twenty-four feet square. This was made gas-tight by covering with paraffine dissolved in naphtha. The tent was shipped to Plainville, and on November 11 the trees were fumigated. The sheet was not large enough to cover the trees, so the trees were cut back enough to take the tent, the severed branches being burned. Plate II shows the appearance of the tree after cutting back and when covered by the tent. On January 20th a careful examination of the trees failed to reveal any living insects.

HOW TO TREAT AN INFESTED ORCHARD.

Suppose we have a badly-infested orchard of peach or apple trees, how shall we treat it? This is a problem confronting many commercial fruit-growers in Connecticut to-day, as well as a large number of persons who have small orchards for the home supply.

In the light of our present knowledge of what has been accomplished in Connecticut and elsewhere the following treatment seems to be the proper one to apply:

1. Remove all worthless trees. It will not pay to treat them.

2. Cut back severely, especially the branches that have lost a portion of their vitality because infested. This will enable the trees to make a stronger growth in the spring and reduce the area to be covered with the spray. The remaining portion being nearer the ground can be sprayed more economically than the ends of the twigs. Burn all branches cut off; fire is an effective scale destroyer.

3. Spray the pruned trees during the winter months with the lime, sulphur, and salt mixture, taking pains to coat thoroughly all portions of the trunk from the ground to the ends of the

branches. This will not injure the trees and it is believed to be a good fungicide as well as an insecticide.

4. The trees may be sprayed with oil, but crude oil should be applied in 25 per cent. mixture just before the buds start, and some injury is to be expected.

5. If the orchard is a small one of young trees and isolated from other fruit trees, fumigating with hydrocyanic acid gas may be profitable, but is very expensive on large trees. Each tree must be covered with a gas-tight tent.

6. When growth begins, fertilize liberally and cultivate thoroughly to promote the vigor and health of the trees.

THREE NATURAL ENEMIES OF THE SAN JOSÉ SCALE-INSECT IN CONNECTICUT.

Chilocorus bivulnerus Muls.

On May 26 the writer visited the grounds of Mr. J. L. Raub on the outskirts of New London, the locality where the San José scale was first discovered in Connecticut in 1895. Mr. Raub experimented with various insecticides, but had to depend upon hired and unskilled workmen to apply them, and the results were rather unsatisfactory. He also employed "dendrolene" quite extensively when that substance was being recommended, and many trees were killed. With the number destroyed by the scale, his fruit plantation was thus considerably depleted. Becoming discouraged with the outlook, Mr. Raub abandoned his place in 1900 and moved into the city, where he has since resided, and for two years no measures had been taken to check the spread of the scale. Natural enemies of the insect had not been idle, however, for some of the trees had taken on new vigor and were not so badly infested as they had been previously. On one apple tree, which was especially noticeable, the adults of the twice-stabbed lady-beetle, *Chilocorus bivulnerus* Muls., were very abundant, traveling about over the infested branches. Many scale-insects were examined and but few living ones were found. The beetle was also present on other trees of the orchard and seemed to be fairly effective in destroying the scale.

The twice-stabbed lady-beetle was received from Stratford, June 4, where it was reported as being very abundant in the neighborhood and devouring the scale-insects on plum trees.

The writer has observed this lady-beetle in different parts of the State, where it has been distributed for many years, but in no place has he found it as abundant as at New London, and nowhere else has he considered it an important factor in keeping the scale in check. The twice-stabbed lady-beetle, which is shown in figure 1, is a small black beetle about one-eighth of an inch in length, with a red spot on each wing. It occurs nearly all over the United States, and in California is said to have effected the extermination of the San José scale in some of the orchards of Tulare county.* Dr. Howard states† that in the East, though common, this lady-beetle does not seem to be attracted to the scale.

Pentilia misella LeC.

Late in the fall (November 5), while looking over an infested orchard at Hartford, my attention was attracted to some very

FIG. 1.—The Twice-stabbed Lady-Beetle *Chilocorus bivulnerus* Muls. Twice natural size.

small black beetles crawling about on the sunny side of the trunk and branches of an apple tree. This proved to be the lady-beetle, *Pentilia misella* LeC., which is considered the most important predaceous enemy of the San José scale in Maryland and Virginia. Adults only were observed in the Hartford orchards and they were devouring the insects, reaching under the shells for the mature and partially grown individuals. Repeatedly did the writer observe the beetles examine young scales, and pass on without devouring them, apparently preferring a more mature morsel. This peculiarity in the feeding habit of the beetle has been mentioned by Dr. Howard,‡ who states that the larvæ feed more abundantly on the newly-hatched scales.

Pentilia misella has also been found in California, where it did efficient work in destroying the scale. It is a very small

*Insect Life, Vol. V, p. 53.

†Bulletin 3, New Series, Div. of Ent., U. S. Dept. of Agr., p. 53.

‡Idem, p. 52.

black beetle, scarcely one-sixteenth of an inch in length. It is shown in figure 2. This beetle was received from Westville, November 15, where it was reported as being very abundant on plum trees.

FIG. 2.—*Pentilia misella* LeC. *a*, beetle; *b*, larva; *c*, pupa; *d*, blossom end of scale-infested pear, showing beetles and their larvæ feeding upon the scales, all greatly enlarged. (After Howard & Marlatt, Bull. 3, N. S. Div. of Ent., U. S. Department of Agriculture.)

A Fungus Enemy.

Twigs were received from Bridgeport, February 13, which had been cut from a scale-infested Japan plum tree. On the twigs were small, hard, black knot-like formations which, upon examination, proved to be one stage of a fungus. Apparently the fungus usually grows upon the dead insects, as these were found to be filled with the mycelium. But few living specimens showed indications of having been attacked by the fungus, and the writer believes this to be generally the case. Specimens were sent to Dr. G. P. Clinton, Botanist of this Station, who was then at Harvard University. He reported that the fungus was not in condition to be determined with exactness, but that it

seemed to be allied to certain stages of *Capnodium,* species of which occur on leaves and twigs that have been infested with plant-lice. He considered it partially parasitic in this case, though generally occurring as a saprophyte—i. e. growing on dead matter. Dr. Clinton stated that he could find nothing about this fungus in literature.

Later the fungus was again received from Bridgeport and the writer observed it at Westville, Bridgeport, New London, Terryville and Hartford. It occurs chiefly on twigs that are well coated with scales, many of which, of course, are dead, but some living individuals on these twigs showed the presence of the fungus. It is doubtful if it will have any considerable influence in keeping the scale in check.

A LIST OF TREES AND SHRUBS AND THEIR SUSCEPTIBILITY TO THE ATTACKS OF THE SAN JOSÉ SCALE-INSECT.

It has been suggested to the writer that a list of ornamental plants not injuriously attacked by the San José scale-insect would be of considerable value to prospective planters. The value of the suggestion has several times been made apparent during the year while engaged in the work of nursery inspection. There seems to be a desire on the part of some nurserymen and landscape gardeners to recommend for planting such species and varieties of trees and shrubs as are most likely to escape injury. The insect is quite universally distributed and we cannot exterminate it. If, however, we can use in the ornamental planting of parks, private and public grounds, trees and shrubs which are exempt from its attack, not only will more satisfactory results be obtained but the cost of caring for the grounds in after years be materially lessened.

Many writers have published lists of food plants of the San José scale, but in 1901, Dr. E. P. Felt, State Entomologist of New York, published a list in three divisions according to observations made in the State of New York. The first division included plants which had not been found infested though growing near badly infested specimens. The second division included those plants on which the insect had been found, but in small quantities and not seriously injured by the infestation. The

third division contained the plants that are found to be badly infested.

This arrangement is of much more value to the public than the ordinary food-plant list, for it gives the planter a chance to learn something about the extent of infestation where it occurs, and it also names the uninfested plants. With the idea of arranging a list that could be safely followed throughout the United States, the following circular was issued to the entomologists and horticultural inspectors of the various states, together with a list of plants upon which observations had been made in Connecticut:—

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.
OFFICE OF STATE ENTOMOLOGIST.

NEW HAVEN, CONN., December 1, 1902.

Dear sir:—Since the introduction of the San José scale-insect into the eastern States, many ornamental trees and shrubs have been attacked by it and destroyed, or at least rendered unsightly. It is apparent in every infested locality that certain species are exempt from attack, and this fact leads one to suppose that the insect cannot thrive as well upon them as upon the kinds commonly infested. If there are kinds of trees and shrubs which the scale does not attack, it is important that nurserymen, planters and landscape gardeners should know about them and urge their use in place of the species most commonly infested.

The writer appends a list of the more common ornamental trees and shrubs upon which he has been able to make observations. These are divided into three classes as follows:

1. Commonly infested.
2. Occasionally or rarely infested.
3. Not infested.

To be of value, such a list should cover not a single State, but the whole country.

Will you, therefore, kindly examine the accompanying list and make such changes as in your experience and observation are necessary to make it fit your locality, and return in the addressed and stamped envelope at your earliest convenience? In case the list is published, due credit will be given to each observer suggesting changes.

Yours very truly,

W. E. BRITTON, *State Entomologist.*

About 80 circulars were sent out and 45 replies have been received. From the replies and from observations made in Connecticut, the writer has prepared the following list. The fruit-trees are included, as they are sometimes planted for ornament, especially the flowering varieties.

The first list includes all plants which have been reported as badly or commonly infested in any locality. The second contains plants which have not been reported as being badly infested anywhere though the insect has been found upon them when near other infested plants. It is believed that in many cases the scale cannot breed upon the plants in this list and therefore they are safe from injury by its attacks.

The third list contains plants upon which the scale has not been reported though many of them probably will later need to be transferred to list number two.

Bailey's Cyclopedia of American Horticulture has been followed regarding the names of plants.

List of Hardy Trees, Shrubs and Vines.

Commonly or Badly Infested.

Acacia sp. Lintner, Felt, N. Y., Alwood, Va.
Akebia sp. Felt, N. Y.
Akebia quinata Decaisne. Alwood, Va.
Amelanchier Canadensis Medic., and other species. Shad-bush, Juneberry. Britton, Koehler, Conn., Alwood, Va.
Citrus trifoliata Linn. Scott, Ga., Alwood, Va., Gossard, Fla.
Cornus alba Linn. var, *Sibirica* Lodd. Britton, Conn.
Cornus Baileyi Coult & Evans. Gould (in N. Y.).
Cornus sanguinea Linn. Britton, Conn.
Cotoneaster sp? Britton, Conn., Lintner, Felt, N. Y., Card, R. I.
Cotoneaster vulgaris Lindl. Alwood, Va.
Crataegus sp. Hawthorn. Britton, Conn., Lintner, Felt, N. Y., Alwood, Va., Smith, N. J.
Crataegus cordata Soland. Koehler, Conn.
Crataegus Oxyacantha Linn., English Hawthorn. Britton, Koehler, Conn.
Crataegus coccinea Linn. Koehler, Conn.
Crataegus Crus-galli Linn. Koehler, Conn.
Cydonia vulgaris Pers. Common Quince. Britton, Conn., Lintner, N. Y., Alwood, Va.
Cydonia Japonica Pers. Japanese or Flowering Quince. Britton, Koehler, Conn., Lintner, N. Y., Alwood, Va., Johnson, Md.
Fagus sylvatica Linn. var *purpurea* Ait. European Purple-Leaved Beech. Smith, N. J.
Juglans Sieboldiana Maxim. Japanese Walnut. Britton, Conn., Alwood, Va., Sherman, N. C., Smith, N. J.
Ligustrum vulgare Linn. Common Privet. Alwood, Va.
Populus sp. Poplar. Britton, Conn., Smith, N. J., Sanderson, Del., Felt, N. Y.

Populus deltoides Marsh. Carolina Poplar. Britton, Conn., Rolfs & Quaintance, Fla., Alwood, Va.

Populus nigra Linn. var *Italica* DuRoi. Lombardy Poplar. Britton, Koehler, Conn., Rolfs & Quaintance, Fla., Alwood, Va.

Prunus amygdalus Stokes. Almond. Lintner, N. Y., Alwood, Va.

Prunus Armeniaca Linn. Apricot. Lintner, Felt, N. Y., Alwood, Va., Smith, N. J.

Prunus Avium Linn. Sweet Cherry. Britton, Conn., Lintner, Felt, N. Y., Alwood, Va., Smith, N. J., Cockerell, N. M.

Prunus pumila Linn. Koehler, Conn.

Prunus pumila var. *Besseyi* Waugh. Sand Cherry. Alwood, Va.

Prunus Cerasifera Ehrh., var. *atropurpurea* Dipp. (*P. pissardi.*) Purple-leaved Plum. Britton, Conn., Felt, N. Y.

Prunus domestica Linn. European Plum. Britton, Conn., Alwood, Va.

Prunus hortulana Bailey. Wild Goose Plum. Alwood, Va.

Prunus Japonica Thunb. Flowering Almond. Britton, Conn., Felt, N. Y.

Prunus maritima Wangh. Beach Plum. Koehler, Britton, Conn.

Prunus Persica Sieb & Zucc. Peach. Britton, Koehler, Conn., Lintner, Felt, N. Y., Alwood, Va., Cockerell, N. M.

Prunus triflora Roxbg. Japanese Plum. Britton, Koehler, Conn., Alwood, Va.

Prunus serotina Ehrh. Koehler, Conn.

Prunus Virginiana Linn. Choke Cherry. Koehler, Conn.

Ptelea trifoliata Linn. Hop Tree. Fernald, Mass.

Pyrus communis Linn. Pear. Britton, Koehler, Conn., Lintner, Felt, N. Y., Alwood, Va., Cockerell, N. M.

Pyrus sinensis Lindl. Sand Pear, including Kieffer, Alwood, Va.

Pyrus baccata Linn. Koehler, Conn.

Pyrus Malus Linn. Apple. Britton, Koehler, Conn., Lintner, Felt, N. Y., Alwood, Va., Doten, Nev., Cockerell, N. M.

Pyrus sp. Crabapple. Britton, Conn.

Ribes oxyacanthoides Linn. Gooseberry. Britton, Conn., Lintner, Felt, N. Y., Alwood, Va., Troop, Ind.

Ribes Aureum Pursh. Missouri or Flowering Currant. Lintner, N. Y.

Ribes rubrum Linn. Currant. Britton, Conn., Lintner, Felt, N. Y.

Ribes nigrum Linn. Black Currant. Alwood, Va.

Rosa sp. Britton, Conn., Lintner, N. Y., Alwood, Va., Cockerell, N. M., Burgess, Ohio, Troop, Ind., Gould, Md., Scott, Ga.

Rosa Carolina Linn. Koehler, Conn.

Rosa lucida Ehrh. Koehler, Conn.

Rosa Virginiana Mill. Koehler, Conn.

Rosa rugosa Thunb. Britton, Koehler, Conn.

Salix sp. Willow. Britton, Conn., Felt, N. Y., Sanderson, Del.

Salix lucida Muhl. Koehler, Conn.

Salix pentandra Linn. Laurel-leaved Willow. Lintner, N. Y., Alwood, Va.

Salix vitellina Linn. Koehler, Conn.

Salix Babylonica Linn. Weeping Willow. Lintner, N. Y., Alwood, Va.

Salix humilis Marsh. Koehler, Conn.

Salix incana Schrank. Koehler, Conn.

Sorbus sp. Mountain Ash. Felt, N. Y., Hunter, Kan.
Sorbus Americana Marsh. American Mountain Ash. Britton, Koehler, Conn., Alwood, Va.
Sorbus Aucuparia Linn. European Mountain Ash. Britton, Koehler, Conn.
Sorbus melanocarpa C. Koch. (*Aronia nigra* Koehne.) Black Chokeberry. Koehler, Conn.
Symphoricarpus racemosus Michx. Snowberry. Felt, N. Y., Smith, N. J.
Syringa vulgaris Linn. Common Lilac. Burgess, Ohio, Com. of Agr., N. Y., Troop, Ind., Alwood, Va.
Syringa Persica Linn. Persian Lilac. Britton, Conn.
Tilia sp. Basswood, Linden. Britton, Conn., Lintner, Com. of Agr., N. Y.
Tilia Americana Linn. American Linden or Basswood. Britton, Conn., Alwood, Va.
Toxylon pomiferum Raf. Osage Osage. Britton, Conn., Lintner, Felt, N. Y., Alwood, Va.
Ulmus sp. Elm. Lintner, N. Y., Webster, Ohio, Troop, Ind.
Ulmus Americana Linn. American Elm. Britton, Koehler, Conn., Alwood, Va.
Ulmus campestris Smith. English or European Elm. Britton, Conn., Felt, N. Y., Smith, N. J.

Occasionally or Rarely Infested.

Acer sp. Maple. Webster, Burgess, Ohio, Fernald, Mass., Butz, Penn., Com. of Agr., N. Y.
Acer saccharinum Linn. Silver Maple. Gould, Md., Alwood, Va., Hunter, Kan., Felt, N. Y.
Acer saccharinum. Weir's Cut-Leaved. Felt, N. Y.
Acer platanoides Linn. Norway Maple. Gould, Md.
Actinidia arguta Mig. (*A. polygama.*) Alwood, Va.
Æsculus Hippocastaneum Linn. Horse-Chestnut. Felt, Com. of Agr., N. Y., Burgess, Parrott, Green, Ohio.
Alnus sp. Alder. Felt, N. Y., Alwood, Va.
Ampelopsis quinquefolia Michx. Virginia Creeper. Alwood, Va.
Betula sp. Birch. Felt, N. Y.
Betula alba Linn. Cut-Leaved White Birch. Britton, Conn., Rolfs & Quaintance, Fla.
Buxus sp. Box. Britton, Conn.
Castanea Americana Raf. Chestnut. Rolfs & Quaintance, Fla., Alwood, Va., Felt, N. Y.
Catalpa sp. Rolfs & Quaintance, Fla.
Catalpa bignonioides Walt. Common Catalpa. Alwood, Va.
Ceanothus Americana Linn. Koehler, Conn.
Celtis occidentalis Linn. Koehler, Conn.
Cercidiphyllum Japonicum Sieb & Zucc. Britton, Conn.
Citrus Aurantium Linn. Gossard, Fla.
Cornus alternifolia Linn. Koehler, Conn.

Cornus stolonifera Michx. Koehler, Conn.
Cornus circinata L'Herit. Koehler, Conn.
Cornus Amomum Mill. Koehler, Conn.
Cornus candidissima Marsh. Koehler, Conn.
Cornus florida Linn. Com. of Agr., Felt, N. Y., Britton, Conn.
Cornus florida. Red flowering. Alwood, Va.
Deutzia sp. Fernald, Mass.
Diospyros Virginiana Linn. Persimmon. Lintner, N. Y.
Elæagnus sp. Felt, N. Y.
Elæagnus longipes Gray. Silver Thorn. Com. of Agr., N. Y., Scott, Ga.
Eucalyptus sp. Felt, N. Y.
Euonymus sp. Lintner, N. Y., Alwood, Va.
Ficus Carica Linn. Fig. Felt, N. Y.
Forsythia sp. Com. of Agr., N. Y.
Fraxinus sp. Ash. Felt, N. Y., Butz, Penn.
Fraxinus Americana Linn. White Ash. Hunter, Kan.
Gleditschia tricanthos Linn. Honey Locust. Britton, Conn., Sanderson, Del., Com. of Agr., N. Y., Johnson, Md.
Hibiscus Syriacus Linn. Shrubby Althea. Smith, N. J.
Hicoria Pecan Britt. Pecan Nut. Lintner, N. Y., Alwood, Va., Scott, Ga.
Juglans nigra Linn. Black Walnut. Alwood, Va., Rolfs & Quaintance, Fla.
Juglans regia Linn. Persian or English Walnut. Alwood, Va., Lintner, Felt, N. Y., Sanderson, Md.
Kalmia latifolia Linn. Mountain Laurel. Felt, N. Y.
Kerria Japonica DC. Globe Flower. Japanese Rose. Felt, N. Y.
Ligustrum ovalifolium Hassk. California Privet. Britton, Koehler, Conn.
Lonicera sp. Honeysuckle. Felt, N. Y.
Morus sp. Mulberry. Alwood, Va., Burgess, Ohio, Johnson, Md., Scott, Ga.
Morus sp. Tea's Weeping Mulberry. Taft, Mich.
Physocarpus opulifolius Maxim. Koehler, Conn.
Picea alba Link. White Spruce. Fernald, Mass.
Prunus Cerasus Linn. Sour Cherry. Felt, N. Y., Alwood, Va., Burgess, Ohio.
Photinia villosa DC. Koehler, Conn.
Rhodotypos kerrioides Sieb & Zucc. Koehler, Conn.
Rhus sp. Sumac. Rolfs & Quaintance, Fla., Alwood, Va., Felt, N. Y.
Rhus cotinus Linn. Smoke Bush. Com. of Agr., N. Y.
Robinia sp. Locust. Sanderson, Del., Burgess, Webster, Ohio, Johnson, Md.
Rubus strigosus Michx. Red Raspberry. Alwood, Va., Lintner, Felt, N. Y., Johnson, Md.
Rubus nigrobaccus Bailey. (*R. villosus.*) Common Blackberry. Lintner, Felt, N. Y., Johnson, Md.
Rubus villosus Ait (*R. Canadensis*). Dewberry. Felt, N. Y.
Sambucus sp. Elder. Com. of Agr., N. Y., Fernald, Mass., Webster, Ohio.

Sassafras officinale Nees. Sassafras. Sanderson, Del.
Sorbaria sorbifolia A. Braun. (*Spiræa sorbifolia* L.) Britton, Conn.
Spiræa sp. Britton, Conn., Lintner, Felt, N. Y., Alwood, Va.
Thuya occidentalis Linn. Arborvitæ. Fernald, Mass.
Viburnum sp. Britton, Conn., Alwood, Va.
Viburnum cassinoides Linn. Britton, Koehler, Conn.
Viburnum Opulus Linn. Koehler, Conn.
Vitis sp. Grapes. Britton, Conn., Felt, N. Y., Alwood, Va., Butz, Penn., Rolfs & Quaintance, Fla., Johnson, Md.

NOT INFESTED.

Ailanthus glandulosa Desf. Tree of Heaven.
Amorpha fruticosa Linn.
Andromeda sp.
Aralia spinosa Linn. Hercules' Club.
Aristolochia macrophylla Lam. Dutchman's Pipe.
Asimina triloba Dun. Papaw.
Baccharis halimifolia Linn. Groundsel Tree.
Benzoin odoriferum Nees. (*Lindera Benzoin* Blume.) Spice Bush.
Berberis (All species). Barberry, including *Mahonia.*
Bignonia sp. Trumpet Vine.
Calycanthus floridus Linn. Carolina Allspice, Sweet-scented Shrub.
Carpinus sp. Hornbeam.
Cedrus sp. Cedar.
Celastrus scandens Linn. Bitter Sweet.
Cephalanthus occidentalis Linn. Button Bush.
Cercis Canadensis Linn. Judas Tree, Red Bud.
Chamaedaphne calyculata Moench. (*Cassandra.*) Leather Leaf.
Chionanthus Virginica Linn. Fringe Tree.
Cladrastis tinctoria Raf. Yellow Wood.
Clethra alnifolia Linn. Sweet Pepperbush.
Corylus sp. Filbert. Hazelnut.
Daphne Mezereum. Linn.
Diervilla sp. Weigela.
Dirca palustris Linn. Leatherwood, Moosewood.
Exochorda grandiflora Lindl. Pearl Bush.
Gaylussacia sp. Huckleberry.
Genista tinctoria Linn. Dyer's Greenweed.
Ginkgo biloba Linn. Maidenhair Tree.
Gymnocladus Canadensis Lam. Kentucky Coffee Tree.
Halesia tetraptera Linn. Silver Bell, Snowdrop Tree.
Hamamelis Virginiana Linn. Witch Hazel.
Hedera Helix Linn. English Ivy.
Hicoria sp. (Excepting *H. Pecan* Britt.) Hickory.
Hydrangea (All species).
Hypericum Moserianum Andre. Gold Flower.
Ilex sp.

Itea Virginica Linn. Virginian Willow.
Jasminum nudiflorum Lindl. Yellow Jasmine.
Juglans cinerea Linn. Butternut.
Juniperus sp. Juniper.
Koelreuteria paniculata Laxm. Varnish Tree.
Laburnum vulgare Griseb. Golden Chain.
Larix sp. Larch.
Liquidambar styraciflua Linn. Sweet Gum.
Liriodendron Tulipifera Linn. Tulip Tree.
Lycium halimifolium Mill. Matrimony Vine.
Magnolia (All species).
Myrica cerifera Linn. Wax Myrtle.
Nyssa sylvatica Marsh. Tupelo, Pepperidge, Black Gum, Sour Gum.
Ostrya Virginica Willd. Horn Beam, Iron Wood.
Paulownia imperialis Sieb. & Zucc.
Phellodendron sp.
Philadelphus coronarius Linn. Mock Orange, Syringa.
Pinus sp. Pine.
Platanus occidentalis Linn. American Plane. Buttonwood.
Potentilla fruticosa Linn.
Quercus (All species). Oak.
Retinispora (All species). Japan Cypress.
Rhamnus sp. Buckthorn.
Rhododendron sp.
Sciadopitys verticillata Sieb. & Zucc. Umbrella Pine.
Shepherdia sp.
Smilax sp.
Sophora Japonica Linn. Japan Pagoda Tree.
Staphylea sp. Bladder Nut.
Stephanandra flexuosa Sieb. & Zucc.
Styrax Japonica Sieb. & Zucc.
Tamarix sp.
Taxodium distichum Rich. Bald Cypress.
Taxus sp. Yew.
Tecoma radicans Juss. Trumpet Creeper.
Tsuga Canadensis Carr. Common Hemlock.
Vaccinium sp.
Wistaria sp.
Xanthoceras sorbifolia Bunge.
Xanthoxylum Americanum Mill. Prickly Ash.

Certain species have been reported as seriously infested in one part of the country and as exempt in other localities. Such plants have been placed in list No. 1. Quince is reported as being rarely infested, by Felt, of New York, and by Smith, of New Jersey. Sanderson writes that willows and poplars are not

commonly infested in Maryland and Delaware, but in Connecticut willow hedges have been seriously infested and young willow and poplar trees in nurseries have been thoroughly encrusted by the scales. Cockerell reports that osage orange is not infested in New Mexico though much grown, and that *Catalpa* elm and walnut have not been found infested. Apricot, quince and poplar are also reported as not being infested in New Mexico. Alwood of Virginia, Burgess of Ohio, and Felt of New York place the sour cherry (*P. cerasus*) in list No. 2, though I have never found it infested in Connecticut. Burgess suggests that Kieffer pear be placed in the same list, but it is reported by Alwood as being badly infested in Virginia. Linden was placed in list No. 1 by the Commissioner of Agriculture of New York, while the hop-tree (*Ptelea trifoliata*) was placed in the same list by Fernald of Massachusetts. Elm was placed in list No. 1 by Webster in Ohio and Troop of Indiana. Smith of New Jersey finds European elm, purple-leaved beech, and Japanese walnut badly infested, while the common quince, cherry (except on Japanese stock), apricot, and poplar are not commonly infested. He has not seen the scale on birch, linden, persimmon, *Catalpa, Acacia* or *Buxus.* Alwood of Virginia puts the common privet (*L. vulgare*) in list No. 1, while Koehler, in Connecticut, mentions it as one of the plants upon which he has not found the scale though growing near infested plants. Gossard of Florida, Scott and Fiske of Georgia, report *Citrus trifoliata* as being badly infested, while Alwood of Virginia places this plant in list No. 2. *C. Aurantium,* the common orange, is rarely infested, according to Gossard.

In Connecticut the most commonly infested plants are apple, pear, peach, Japan plum, and currant among the fruits, though sweet cherry, European plum, quince and gooseberry are sometimes seriously injured.

The most commonly infested ornamentals are purple-leaved plum, *Crataegus,* Japanese quince, mountain ash, red-twigged dogwood and *Rosa rugosa.* Poplar, willow, Persian lilac, *Cotoneaster,* elm (both American and European), and osage orange have been found thoroughly encrusted by the insects, especially when growing near infested trees.

THE APPLE-TREE TENT-CATERPILLAR.*

Clisiocampa americana, Harris.

One of the chief leaf-eating enemies of the apple orchard is the tent-caterpillar. Though not as injurious as some other pests, it is, perhaps, the most obvious one, for by it the trees are stripped of their foliage early in the season. As it forms conspicuous nests on the wild cherry and apple trees, its presence is evident to all, and as it may be easily destroyed there is really no excuse for allowing it to attack and seriously injure orchards. This insect is distinguished from others that feed upon the leaves by the nests or tents which it makes on the branches early in May. The caterpillars remain inside the nest through the night and during cloudy weather, coming out to feed for a short time each pleasant day.

Fruit growers are apt to confuse the tent-caterpillar with the fall web-worm, an insect which makes nests on the ends of the branches of fruit and forest trees during August and September. The two species are quite different and can easily be distinguished if we remember that the former occurs only in spring, and that the caterpillars stay inside the tent in bad weather, but go out of it to feed. The fall web-worm appears in late summer, and the feeding is done wholly within the nest. A few leaves are enclosed in the web, and after these have been eaten, the web is enlarged to include fresh leaves, which in turn are devoured. Sometimes an entire branch is thus enclosed by the nest of the fall web-worm.

The tent-caterpillar is sometimes wrongly called the "bag-worm." The bag-worm is a very different insect. Bag-worms do not live together in large nests like tent-caterpillars, but each larva forms a small bag or case from one to two inches long in which the body is enclosed. The entire larval period and the pupa stage are passed in this case and the female lays eggs in it for the following generation.

The apple-tree tent-caterpillar also differs from, though closely allied to, the forest tent-caterpillar, which has caused much injury to fruit, shade and forest trees in Vermont, New

*This matter was printed as Bulletin 139 and distributed in July, in an edition of 11,000 copies. It is reproduced here with slight emendations.

Hampshire and northern New York during the past few years. Notwithstanding its name, the forest tent-caterpillar forms no tent.

The apple-tree tent-caterpillar is a native of North America and probably occurs throughout the United States and Canada, but is most abundant in the Eastern States. Though damage by this insect was recorded as early as 1646, the species was first named and described by Dr. T. W. Harris only fifty years ago.

Abundance in Connecticut in 1902.

Though the nests are seen every spring in Connecticut, the insect has not usually been as destructive here as in northern New England.

The wild cherry furnishes the common food supply, and often the injury does not extend to apple orchards.

The present season, however, the tent-caterpillar has been abundant everywhere and has attacked not only cherry and apple trees, but several other kinds. One grower reports this as the most troublesome pest on his peach trees. The black cherry trees and choke cherry bushes along roadsides and hedge rows were stripped of leaves. According to our observations, the outbreak was not a local one, but occurred over the whole State. It was somewhat more severe in the northern portion. The three agents employed by the Station to gather fruit statistics, who have covered the entire State in their travels, have reported defoliated trees in nearly every town. The writer has made similar observations in those portions of the State in which he has occasion to travel.

Moreover, of all orchard insects the tent-caterpillar is the most commonly reported by the fruit growers.

Mr. T. S. Gold believes that the insect has not been so abundant for sixty-six years or since the terrible ice storm of 1836.

Food Plants.

The black and choke cherry are the favorite and probably the natural food-plants of the species. The apple is the next choice, and in seasons when the caterpillars are numerous

orchards are attacked and sometimes entirely defoliated. Lowe mentions* cherry, apple, plum, peach, rose, witch hazel, beech, barberry, oak, willow and poplar as food plants. Weed found the caterpillars feeding upon birch,† and the writer has occasionally found them eating the leaves of various species of oak.

Habits and Life History.

The eggs are laid in cylindrical masses encircling small twigs of the apple and cherry, during the last days of June or first of July. Specimens in breeding cages in the laboratory laid eggs soon after the middle of June, but this is somewhat earlier than they are laid upon the trees out of doors. After depositing a ring of eggs averaging over two hundred in number, the parent moth covers the eggs with a viscid fluid which hardens, giving them a varnished appearance. The eggs are probably greatly protected by this coating from the weather and from predaceous insects. See Fig. 3.

The eggs do not hatch until the following April, thus remaining upon the twigs for about nine months. The tiny caterpillars first feed upon the frothy mass surrounding the eggs, and next attack the new leaves which are then unfolding. After a few days they spin many silken threads to form their nest, usually in a fork of the branches.

This nest or colony contains the caterpillars from a single mass of eggs. Except when feeding they remain in the nest, but when nearly full-grown, the caterpillars may often be found at rest on the outside of the tent. (See Plate VI.) They spin threads wherever they crawl along the branches from the nest to their feeding places.

The egg-masses do not all hatch at the same time, and it is not uncommon to find half-grown and newly-hatched caterpillars in the same vicinity. Mr. J. M. Whittlesey, of Morris, Conn., states in a letter to the writer, that during the spring of 1902 the hatching period extended over nearly twenty-one days.

The average feeding period is about six weeks, during which time the caterpillars have molted or cast their skins several

* Bulletin 152, N. Y. Agr. Exp. Station, p. 281.

† Bulletin 38, N. H. Agr. Exp. Station, p. 53.

times. As they increase in size they become more voracious and devour the leaves rapidly. At each molting period they stop feeding for a few hours, then begin again with renewed vigor.

When fully grown the caterpillars cease eating and wander about restlessly for a day or two, then spin white silken cocoons in the grass under the trees, in the crevices of the rough bark, or about buildings, boxes, etc., that may be near the infested trees.

There is only a single brood each year.

A colony of tent-caterpillars was brought into the laboratory on May 1st. The nest had been formed, though the caterpillars were small, measuring about three-sixteenths of an inch in length. They had probably been hatched about a week and are shown on Plate V. On May 26th, they had become full-grown and three or four were pupating. In a week all had made their cocoons and by the 16th of June the adults began to emerge. This continued for nearly a week, until all had come forth. Meantime several egg-masses had been formed in the breeding cage by the females.

Description.

Egg. The eggs are grey in color and very small, being about one-eighteenth of an inch long, and slightly more than half as thick. The upper end is circular, and is slightly larger than the lower end. They are placed on end, close together, and covered one-sixteenth of an inch deep with a brown substance resembling glue. The whole mass usually encircles the twig, but is sometimes deposited on one side only. An egg-mass is shown in Fig. 3.

Larva. When first hatched, the caterpillar is very small and nearly black with a few grey hairs.

It molts five or six times as it increases in size, and after each molt the markings show more distinctly. When full-grown the caterpillar is from two to two and one-half inches in length and is thinly covered with long light-brown hairs.

The color is black with a white stripe along the back, and many short irregular brownish stripes or markings along the side of each segment. The sides are of a bluish color and each segment bears an oval blue spot nearly surrounded with black.

The under side of the body, head, and legs are black. A full-grown larva, natural size, is shown on Plate IV.

Pupa. The pupa stage is passed in a white, oval cocoon, which is about one inch in length and half an inch in thickness. It is made of silken threads spun by the caterpillar and loosely woven. It is usually attached by one side to some object in a more or less protected place. Plate VII shows a few of the cocoons.

FIG. 3.—Egg-mass on Apple Twig; natural size.

Adult. The adult is a four-winged moth of light reddish-brown color with two whitish stripes, extending obliquely across each fore wing. The female has a wing expanse of about one and one-half, and the male about one and one-eighth inches. The males are inclined to be somewhat darker in color than the females, though there is much variation in the intensity of the ground color and of the markings in both sexes.

The rear wings are the same color as the fore wings, but are not marked with white stripes. Both sexes are shown on Plate VII.

Natural Enemies.

The tent-caterpillar is usually held in check to a considerable extent by its natural enemies; in fact, but for them it would be much more abundant and destructive each season. Its abundance the present season is due to a comparative scarcity of natural enemies, thus allowing the species to multiply unchecked.

An ichneumon fly, *Pimpla inquisitor* Say., is a common parasite of the tent-caterpillar, and there is a bacterial disease which in some seasons destroys the larvæ in large numbers. If the latter is prevalent, large numbers of dead caterpillars are found about the trees and nests.

Birds are important factors in the control of this pest, the cuckoos playing an important part. The crow, chickadee, oriole, chipping sparrow, yellow warbler, and red-eyed vireo are other birds that feed upon the caterpillars.

This season we have not observed the presence of the bacterial disease, or unusual abundance of the ichneumon parasites,—while the trees now have a great number of egg-masses, indicating that the insect will be abundant next season. Farmers and fruit growers should therefore be ready to combat it.

Remedies.

Destroying the Eggs.

Much can be done through the winter months in destroying the egg-masses. When the trees are bare these can be seen near the ends of the twigs, and may easily be clipped off by means of a tree pruner having a long handle, which enables the operator to reach and cut off the egg-masses while standing upon the ground. These should then be gathered and burned.

Professor Weed recommends that children be given a small bounty for gathering egg-masses and cites a case in Newfields, N. H., where they were offered ten cents per hundred clusters, by the village improvement society. 8,250 egg-masses were collected, and if each cluster contained 150 eggs, which is a small average, 1,237,500 eggs were destroyed at a cost of $8.25.*

* Bulletin 17, New Series, Division of Entomology U. S. Department of Agriculture, p. 77.

Many writers advise the destruction of the wild cherry and seedling apple trees, which harbor the tent-caterpillar along the hedge-rows and roadsides.

If not destroyed, the owner should certainly care for these trees to the extent of keeping them free from insects, and not allow them to be a menace to his neighbor or the orchards of the vicinity.

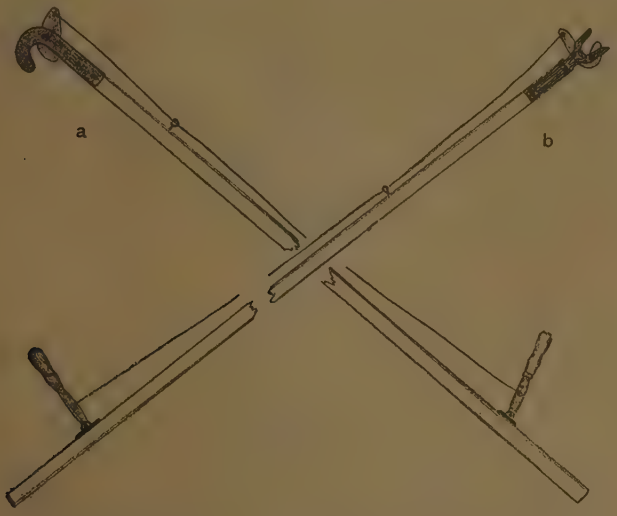

FIG. 4.—*a*, Waters' Tree Pruner; *b*, Henry's Tree Pruner.

Brushing off the Nests.

Twenty years ago the writer used to be sent through the orchards with a brush mounted on the end of a pole to remove the nests from the trees in the early morning or on a cloudy day when the caterpillars were in them.

The brush was made of stiff bristles twisted in heavy wire and trimmed to the shape of a cone about six inches long. It was made for the purpose, and worked admirably.

The operator stands upon the ground, inserts the point of the brush in the nest and gives it a few turns, and the entire nest with contents is wound upon the brush. The caterpillars may then be easily destroyed by crushing upon the ground.

During recent years I have not been able to find this brush on the market, but the M. Leiner Company of 1250 Brook avenue, New York, has been making some samples after my specifications and will be prepared to manufacture it in the future if there is a demand for it. The cost will be less than fifty cents at wholesale or even in dozen lots. Local dealers

FIG. 5.—A caterpillar brush.

and seedsmen should procure a supply and be ready to sell them to fruit growers next spring. The appearance of the brush is shown in Figure 5.

Burning.

Some fruit growers practice burning the nests on the trees and for this purpose an asbestos torch has been designed and manufactured. The torch is filled or covered with kerosene, lighted, and held under the nest when the caterpillars are inside. We do not recommend burning, because there is danger of severe injury to the tree. Where the nests are near the ends of the branches the damage may be very slight, but as the tent-caterpillars often make their tent at the fork of comparatively

large branches, it cannot be burned without danger of killing these branches. Brushing off the nests with a caterpillar brush is just as expeditious as burning and there is no danger of injuring the trees.

Spraying.

Where the orchardist practices early spraying no other remedy need be considered. Arsenate of lead or Paris green, with or without Bordeaux mixture, applied to the foliage will kill the caterpillars. The chief difficulty lies in the fact that some of the caterpillars hatch and begin feeding as early as the first leaves appear and before there is really any leaf-surface to poison; some damage may be done before spraying begins. But, as the caterpillars eat very little at first, this damage is not liable to be serious. These early colonies may be brushed from the trees, and the spray depended on to kill the later ones.

A half pound of Paris green or three pounds of arsenate of lead should be used for each 50 gallons of water or the same quantity of Bordeaux mixture. Where Paris green is used without Bordeaux mixture, three pounds of fresh lime to one of poison should be used to prevent burning the leaves. As the Bordeaux mixture contains plenty of lime, no more is needed in connection with it. Arsenate of lead is perfectly insoluble in water, does not injure foliage, and therefore does not need the addition of lime. Paris green contains a little free acid which is soluble in water, and which unless neutralized may burn the foliage.

Summary.

1. The apple-tree tent-caterpillar, a native insect and one of the chief leaf-eating enemies of the orchard, has been very abundant throughout Connecticut the present season and has injured fruit trees by defoliating them in May. Wild cherry is probably the natural food of the species, but when abundant it attacks apple and other fruit trees.

2. Eggs are laid on the twigs of the food plant in summer and hatch the following April. After a few days the young caterpillars form on the branches a nest in which they live, going out from it to feed. They are always within the nest

at night and in cloudy weather. They become full-grown in about six weeks and spin white silken cocoons from which the adults emerge two weeks later.

3. The small grey eggs are deposited in masses of 200 or more encircling the twigs, and are covered with a brownish substance. The full-grown caterpillar is over two inches long, black above and below, and blue on the sides, with a white stripe along the back. It is thinly covered with light brown hairs. The white cocoon is about one inch in length and half an inch in thickness. The adult is a reddish-brown moth with two whitish stripes extending obliquely across each fore wing.

4. The species is usually held in check by its natural enemies, which consist of several kinds of birds, parasitic insects and a bacterial disease.

5. The remedies are: to gather and destroy the egg-masses during the winter months; spray when the leaves appear, using three pounds of arsenate of lead or one-half pound of Paris green to 50 gallons of water or Bordeaux mixture; if impracticable to spray, brush off the nests as soon as they can be found, choosing the early morning or cloudy weather, when the caterpillars are inside the nest; burning the nests on the trees is not to be recommended.

THE WHITE-FLY OR PLANT-HOUSE ALEYRODES.*

Aleyrodes vaporariorum Westw. ?

For eight years the most serious insect pest affecting forcing-house tomatoes at the Station has been the "white-fly," "mealy-wing," or plant-house Aleyrodes. Were it impossible to hold the insect in check, the crop each winter would be nearly a total failure. Seemingly the species grows more and more abundant each succeeding year; at least the remedies need to be applied with greater persistence than formerly, and in spite of all the spraying and fumigating a goodly number of individuals survive.

The attacks of the white-fly are by no means confined to

* This paper was published as Bulletin 140, in an edition of 10,500 copies, and sent out in December. It is here reproduced with appropriate emendations.

the tomato plant, but other forcing-house crops, especially cucumbers and lettuce, are sometimes seriously injured. There is a large number of florists' plants upon which the insect is known to live, and several of them are each year much damaged by its attacks. Nor are the depredations of this insect limited to plants under glass; on the contrary, it lives and multiplies on the out-door plants of the garden through the summer, frequently causing more or less injury. The white-fly has already been reported as injuring strawberry plants in Kentucky* and New York,† and we may expect similar accounts of it from other localities.

In 1901 the white-fly was sent to the Station from Bridgeport, where it was damaging aster and chrysanthemum plants. In July, 1902, specimens were received from Milford and Saugatuck on strawberry leaves, and in November on geranium leaves from New Haven. Just before this report was printed, specimens were received from Pomfret on tomato. In December adults were sent to the writer from Levis, Quebec, Can., where *Fuchsia* and *Eupatorium* were infested. In all probability this is the same species, though without the pupa cases or larvæ identification is impossible. Prof. Fletcher informs me that the white-fly has been present in the greenhouses of the Central Experimental Farm, at Ottawa, Can.

While on a vacation in August the writer observed that aster plants growing in a garden in Surry, N. H., were infested with this insect.

The original home of this Aleyrodes is unknown. Westwood states that it is supposed to have been carried into England on plants from Mexico. It may have been brought here either from England or from Mexico. Quaintance states‡ that it has been received by the Entomologist at Washington from New Haven and Storrs, Connecticut; West Grove, Pa., and Goshen, Ind.

It also occurs in such widely separated regions as Michigan, Illinois, Kentucky, New York, Massachusetts, New Hampshire, Ohio and the District of Columbia, which indicates that it is

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* Report of Kentucky Experiment Station for 1890, p. 37.

† Bulletin 190, Cornell Experiment Station, p. 155.

‡ Bull. 8, Tech. Series, Division of Entomology, U. S. Department of Agriculture, p. 39.

now thoroughly distributed throughout the northeastern portion of the United States.

Relationship to Other Insects.

The *Aleyrodidæ*, to which the white-fly belongs, are closely related to the *Coccidæ*, or scale-insects, being perhaps intermediate between them and the plant-lice, *Aphididæ*. They differ from the former in that both sexes are winged and motile, and from the latter in being fastened to the plant in the nymph stage. The larvæ or nymphs hatch from eggs deposited by the females on the under surface of leaves, and closely resemble several species of scale-insects.

Aleyrodid insects are not considered to be of very great economic importance. They are much more abundant in the tropics than in temperate regions. Many species occur on cultivated and wild plants, but are seldom abundant enough to be a serious menace to them. Signoret's monograph of the *Aleyrodidæ*, published in 1868, contains twenty-three species found in Europe.* Quaintance lists forty-two species† in America, but *A. citri* Riley & Howard, which is a serious pest of the orange and lemon groves of the Southern States, and this plant-house aleyrodes are without doubt the two most important species from the standpoint of the horticulturist.

How it Injures Plants.

The female lays eggs on the under sides of the leaves. Soon after the eggs hatch the young larvæ or nymphs attach themselves to the leaf and injure it by sucking out the sap for their nourishment throughout the period of larval growth. As each female deposits several eggs, and as only a short time is required for the complete cycle of development, successive generations finally cover the entire under surface of the leaf. The tissues collapse from the effects of this continuous pumping out of the life-juices of the plant, and the leaf shrivels and falls. As new leaves are formed at the top of the plant these in turn become infested, and later wither and die. If no efforts are made to

* Annales de la Societé Entomologique de France, 1868, p. 387.

† Bull. 8, Tech. Series, Division of Entomology, U. S. Dept. of Agriculture.

destroy the pest, the entire plant may be dead before the end of the season, or if it be a vigorous grower like the tomato, may have a few green leaves at the top, with a bare stem from which the leaves have withered and dropped. In the greenhouses the insects usually become very abundant towards the end of the season, and the warm days of spring seem to favor their multiplication: this occurs in our tomato house nearly every year in spite of a weekly spraying which kills all adults with which the material comes in contact. As the season advances the plants in the garden become infested and the species keeps multiplying out of doors until cold weather approaches, when it again appears in the greenhouse, there to pass the following winter.

Though most of the feeding is done in the nymph stage, the adult is provided with mouthparts well fitted for sucking and probably injures plants to some extent. I have often seen adults resting on the lower surfaces of leaves with their beaks piercing the tissues. When disturbed they fly upward, and if abundant they literally fill the upper portion of the greenhouse. A sweet sticky substance called honeydew is exuded by the larvæ, and this covers the fruits and lower leaves of the plants during the latter part of the winter. A black fungus grows in the honeydew, giving the plants the appearance of having been covered with soot.

Food Plants.

Although in forcing-houses the white-fly has been most troublesome on tomato, cucumber and melon plants, and the florists must fight it persistently on *Ageratum, Lantana* and heliotrope, I believe that it is able to live upon and may attack almost any kind of plant if the preferred ones are not at hand. Solanaceous plants (those belonging to the potato family) are favorites, and tobacco growing at the Station in 1901 was badly infested. Should this insect become established in the tobacco fields of Connecticut, it would doubtless prove a very troublesome pest.

The following list contains only those plants upon which I have observed the insect in its nymph stages: the adults have been found resting upon the leaves of a great many other kinds of plants.

Abutilon sp.
Ageratum mexicana.
Aster.
Bean.
Berberis Thunbergi.
Calla lily.
Campanula sp.?
Catalpa.
Chrysanthemum.
Cigar plant (*Cuphea*).
Coleus.
Columbine.
Coreopsis lanceolata.
Cucumber.
Currant.
Erigeron philadelphicum.
Eupatorium.
Fuchsia.
Geranium.
Golden Glow (*Rudbeckia laciniata*).
Grevillea robusta.
Heliotrope.
Hibiscus moscheutos.
Hibiscus rosa-sinensis.
Hickory.
Japan plum.
Lantana.
Lavendula dentata.
Lettuce.
Lilium superbum.
Lonicera.
Maurandya.
Melon.
Monarda.
Morning Glory.
Nasturtium (*Tropæolum*).
Nutmeg (*Schinus molle*).
Oxalis.
Parrot's Feather (*Myriophyllum proserpinacoides*).
Pelargonium.
Phlox.
Phytolacca decandra.
Platycodon.
Potato.
Primula obconica.
Rhodotypos kerrioides.
Rose.
Salvia.
Smilax.
Snapdragon.
Solidago canadensis.
Spice bush.
Spiræa.
Squash.
Strawberry.
Tecoma radicans.
Tobacco.
Tomato.
Verbena.
Zinnia.

Westwood found it on *Tecoma velutina, Gonolobus, Solanum,* and plants belonging to the *Bignoniæ* and *Aphelandræ.*

Habits and Life History.

The plant-house Aleyrodes in all its stages is found on the under sides of the leaves and seldom anywhere else unless disturbed. The eggs are laid on the leaves, perhaps, when the plant is small, and as the new leaves are formed these become the ovipositing places. Thus the lower leaves of large and badly infested plants are usually completely covered on their under surfaces with the empty skins from which the adults have emerged. These leaves are the first to wither and drop. Those

next higher up on the plant will show nymphs and pupæ; still higher we shall find younger and newly hatched nymphs, while on the upper leaves the adults will be mating and the females laying eggs. The process of ovipositing is an interesting one and was observed by the writer a few years ago in two cases on lettuce plants. The female first thrust her beak into the leaf, and depositing an egg, swung about with her beak still inserted and serving as a pivot, continuing to deposit eggs in a circle of about one millimeter in diameter. One of these circles contained six, while another had nine eggs. This peculiar egg-laying habit was observed many years ago by Réaumur in *Aleyrodes chelidonii* as cited by Westwood in the Gardener's Chronicle (1856, p. 852). But our species does not always lay eggs in this manner, for I have often found eggs deposited singly and scattered over the surface of the leaf. Davis has observed that on hairy plants like the *Ageratum* the eggs are deposited singly.

The eggs were light green or nearly white at first but soon changed to a dark color, and hatched in eleven days. The newly-hatched larva moves about for a short time, then becomes stationary and resembles a scale-insect. In increases in size for a time and when fully grown changes to a yellowish color. Still more important changes are taking place inside. This is called the pupa stage. Finally the skin cracks open along the median line of the back, and transversely through the caret-shaped line, and the fully developed insect appears. It is pure white, much resembling a tiny moth, and it is entirely covered with particles of wax. The old pupa skins remain attached to the leaf for a long time. The adults fly about, mate and the female soon begins to lay eggs. It is not known how long the insects live after reaching this stage. From the laying of the egg to the time that the adult comes forth requires a period of about five weeks. Plate VIII shows nymphs and adults on a leaf.

It is not known whether the species can survive the winter out of doors in this climate, but in the cases coming under the writer's observation it has been carried through the cold weather on plants in greenhouses or dwellings.

Description.

Egg.—Length, 200μ to 250μ (.2 to .25 millimeter). Thickness, 90μ to 100μ (.09 to .1 millimeter) in thickest portion. Elongated ovate in shape. White or light green when first laid but soon (three days according to Davis) changing to a dark bluish-black. The large end is attached to the under surface of the leaf by means of a very short and slender thread-like stalk which is difficult to make out. Smooth and shiny or covered with minute granules of white wax. See fig. 6, and Plate X. Eggs observed by the writer hatched in eleven days.

Fig. 6.—Eggs: × 36.

Fig. 7.—Newly-hatched nymph, ventral view: × 55.

Newly-hatched Nymph.—Length, about 252μ (.25 millimeter), width, about 101μ (.1 millimeter). Body thin, showing eyes, vasiform orifice, and caudal setæ, which are probably tactile. Ventral surface shows six poorly developed legs: eyes and antennæ are situated near anterior end of body. Mouth-parts are in form of a sucking tube having its origin just in front of the forelegs. The segmentation is apparent in the abdominal region. See fig. 7.

Full-grown Nymph.—Length, about .75 millimeter. Width, about .5 millimeter though varying considerably in size. Thickness, about .28 millimeter. Greenish-white in color, dorsum mildly convex with several cross sutures indicative of segmentation. One of these has the form of a broad and shallow caret (^) not far from the middle of the body. A median line from the point of this extends to the anterior end of the body, and it is along this line and across through the caret-shaped mark that the skin opens for the adults to emerge. There is a submarginal row of short, white, wax filaments or rods. Under the margin and extending perpendicularly from the horizontal plane of the body to the leaf is a wall of wax made up of

narrow filaments side by side and adjoining each other. This wax fastens the insect to the leaf, and often breaks off in flakes when the nymph is removed and mounted in glycerine. Even when broken off this wall shows the parallel lines or striæ, and it is along these that it separates most readily.

In the fully matured nymph and pupa, long curved waxen rods occur on the dorsum as follows—a pair close to anterior margin and a second pair a short distance back of the first. A third pair on the thoracic region. The fourth and fifth pairs are close together on the abdominal region just back of the caret-shaped cross-mark. The sixth pair is situated near the vasiform orifice and a seventh pair occurs near the posterior margin.

FIG. 8.—Mature nymph or pupa, dorsal view: × 36.

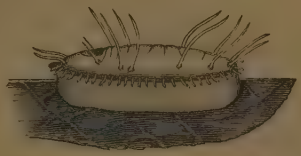

FIG. 9.—Lateral view of mature nymph: × 36.

These rods arise from distinct pores and vary greatly in length. Hairs occur; one on each side of the vasiform orifice, and a pair at the caudal extremity of the body. The mature nymph is shown in figs. 8 and 9.

Adult female.—Length, about 1.5 millimeters from head to ends of folded wings. Wing expanse of about 2.5 millimeters. Body plump and yellow in color, terminating in an ovipositor of three pieces. Four pure white wings extending beyond end of abdomen, each with a single median vein which in the fore wings is branched at the base; a row of papillæ or tubercles resembling beads extends around the margin, and each papilla bears minute hairs. These are shown on Plate XI. Eyes brown, in two pairs, the upper ones slightly smaller than the lower, but with a larger number of facets. Antennæ seven-jointed, the first joint very short, the second thick, the third long, the others about equal in length and all but the first and second with many

ring-like markings. Proboscis of three pieces arising from under the back side of the head and containing a groove in which are four bristle-like lancets. The lancets have a different origin from the proboscis, and arise from the front of the head. Each leg has two tarsal joints, the distal one being furnished with a pair of claws and a spine or bristle-like appendage. Wings, body and legs covered with a powdery white wax. See fig. 10.

FIG. 10.—Adult female: × 36.

Adult male.—Like female, only the body is smaller and more pointed, terminating with the genital organs. Shown on Plate IX.

IDENTITY AND NAME OF THE INSECT.

The insect was first noticed at the Station during the winter of 1894–95, on tomato plants under glass. During 1895, the writer sent specimens to Prof. M. V. Slingerland of Cornell University, and later to Dr. L. O. Howard of Washington, both of whom reported it to be *Aleyrodes*, but that it was impossible to determine the species, for up to this time the *Aleyrodidæ* had received but little study in this country and few American species had been described. Prof. Garman, to whom specimens were sent, pronounced the Connecticut species identical with that which he had reported as attacking strawberry in Kentucky.

During the past year the writer has made several requests for authoritatively determined specimens from England, in order to settle once for all the identity of the insect. Prof. David Sharp of Cambridge very kindly sent some adults from the botanical garden at Cambridge, which presumably were

A. vaporariorum Westw., but as Dr. Sharp makes no claim to a special knowledge of the group, the matter is still unsettled. Moreover the pupa case is needed to determine the species with certainty. The adults from England could not be distinguished from specimens taken in the Station greenhouses.

Garman and Packard, in the works of these authors mentioned on pages 159-160, write of this insect under the name of *A. vaporarium*. Davis uses the name *vaporarium* in 1894 (Insect Life, Vol. VII, p. 174), but in 1896 (Special Bull. 2 Mich. Exp. Station) adopts Westwood's spelling. The difference in the spelling of the specific name is doubtless due to an oversight.

For the generic name some writers use the Greek spelling *Aleurodes,* meaning flour-like, which describes the waxy or mealy appearance of the insects. The present writer has preferred the original spelling as given by Latreille many years ago.

As Westwood's description fits our species very well, it is probable that the two are identical. Westwood described and figured the species in the Gardener's Chronicle for 1856, p. 852. As this is inaccessible to many, the description is here reproduced.

Westwood's Description of *A. vaporariorum.*

The New Aleyrodes of the Greenhouse.—During the past 12 months the greenhouses, both in the public gardens at Kew and in the gardens of the Horticultural Society at Chiswick, have been infested with a new pest, under the appearance of a very minute white four-winged insect, like a miniature moth, to which my attention was first directed by Sir William Hooker, and subsequently by Dr. Lindley. It especially attacks the leaves of Mexican species of *Gonolobus, Tecoma velutina, Bignoniæ, Aphelandræ, Solanums,* and other similar soft-leaved plants, and is supposed to have been imported with living plants or in the packings of *Orchidaceæ* from Mexico, in all cases attaching itself to the under side of the leaf. Here it sits tranquilly with the tip of its short naked sucker or rostrum thrust into the leaf, but on passing the hand over the plants, quite a little white cloud of the insects is raised. They soon, however, settle again to renew their attacks, which are shortly followed by a discoloration and blackening, and subsequent drooping and falling

of the leaves. The ordinary fumigations have been tried, and the winged insects, which are very delicate little creatures, are easily killed, but in a day or two a fresh brood of the perfect insects makes its appearance in as great numbers as before, and this continues to be the case after repeated fumigations. Nor is the placing of the plants out in the open air more successful in getting rid of the enemy, as Mr. Gordon pointed out to me a cluster of plants which had been in the open air for more than a fortnight, and which were swarming with the insects as thickly as those within doors.

The insect when seated with its four wings closed over its back is not larger than the head of a good-sized pin, and were it not for its beautiful clear white colour it would be seen with difficulty. A microscopical examination proves it to belong to the genus *Aleyrodes* (one of those aberrant groups allied to *Aphis* and *Coccus*), of which we possess in this country several native species, one (*A. Chelidonii*) found upon *Chelidonium majus*, and also on the common cabbage; another, first determined by Mr. Haliday, infests the common *Phillyrea*.

The body is soft and rather fleshy, the head distinct, with a pair of antennæ consisting of only six joints, the first large, the second long, and the four following short and slender; the eyes are four in number, each being small and round, the two on each side placed near each other; the rostrum short, fleshy, apparently two-jointed, emitting from its apex a fine-pointed (certainly compound) black seta, which is the real instrument by which the plants are wounded. The whole body, legs, and wings of the insect are covered with a white powdery secretion, analogous to the white floccose matter of the Apple-blight *Aphis*, the white mass in which the eggs of various species of *Coccus* are enveloped, and which is developed in many other Homopterous insects; the wings are of moderate size, rounded at the tips, with a single central strong rib; when at rest they are placed over the back roof-wise, and the legs are rather short and simple.

On examining some of the infested leaves I found them covered with great numbers of flat bodies of extremely delicate texture, fringed with long, straight, slender hairs (having a good deal of the appearance of some small species of mites); their number was greatest on the lower leaves of the plants,

and I counted not fewer than 250 upon a single leaf of moderate size. They are of an oval, flattened form, the margin being very thin; the fore half of the body is occupied by two portions, which shut close by a straight slit along the middle of the back, but are generally seen more or less opened like the doors of a cupboard. These bodies are the envelopes of the pupæ of the Aleyrodes, which have already made their escape in the winged state, but with them were mixed many much smaller specimens of the insect destitute of the fine hairs and very transparent, of a very flat, oval figure, the middle and hinder half of the body exhibiting traces of the abdominal segments, with the anal apparatus placed at some distance from the hinder extremity of the body; the rostrum, very minute and conical, is seen at some distance from the anterior extremity, and around are seen several pairs of tubercles, which seem to represent the eyes, antennæ, and legs, and which are seen much more clearly in Professor Burmeister's figures of the young of *Aleyrodes Chelidonii*.

The present species, although very closely resembling *A. Chelidonii*, differs from it in its smaller size, in having only 6-jointed antennæ, in the want of the dusky spot on each wing, in the more suddenly angled rib in the middle of the fore-wings, and especially in the long straight rigid hairs with which the body of the pupa case is defended, and within which the insect lies concealed for several days, unaffected by external agents (except heat and cold), which circumstance explains the cause of the sudden reappearance of the insect so soon after fumigation. In consequence of its being only hitherto known in greenhouses it may be specifically named *Aleyrodes vaporariorum*. . . . . .

J. O. Westwood.

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1892. Riley. Insect Life, Vol. V., 17. Found on Strawberry in Dist. of Columbia.

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1894. Davis. Insect Life, Vol. VII., p. 174. Brief description. Troublesome in greenhouses in Michigan.

1895. Britton. Conn. Exp. Sta. Rep., p. 203. Brief description and illustrations.

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1897. Britton. Garden and Forest, Vol. X., p. 194. Brief account. Illustrated.

1900. Britton. Conn. Exp. Sta. Rep., p. 311. Fumigating with hydrocyanic acid gas.

1900. Quaintance. U. S. Div. of Ent., Tech. series No. 8, pp. 16 and 39. Distribution and key to the species.

1901. Slingerland. Cornell Exp. Sta., Bull. 190, p. 155. Attacking strawberries in New York. Illustrations from Davis.

1902. Britton. Conn. Exp. Sta. Bull. 140. Full account with description and illustrations.

Remedies.

Fumigating.—Fumigating with tobacco is the remedy that has been oftenest recommended for this insect, but the fumes from the burning of ordinary stems or dust do not kill any considerable number of the insects. Many are stupefied by the fumes and fall from the plants, but revive later and soon become as active as ever. During the past two or three years tobacco used in this way seems to have been less effective in destroying the adults than when the writer first employed it eight years

* This was issued as Special Bull. 2, and bears the date of November, 1896. Later it was found that the bulletin numbers had been duplicated and this was changed to Miscellaneous Bulletin.

ago. Where the adults are stupefied and fall to the ground, a copious watering of the surface of the soil will kill them in great numbers. At the Illinois Experiment Station tobacco fumigation has not been satisfactory.*

Fumigating with hydrocyanic acid gas to kill the white-fly was here first given a trial in 1900 and an account of the experiment was published in the Report of this Station for 1900, page 311. Three ounces of potassium cyanide for each one thousand cubic feet of space were used, and the house closed for thirty minutes. All insects were killed, but the tomato plants were more or less injured. Our experiments as well as those of others indicate that the tomato is more susceptible to the effects of the gas than most plants, and care must therefore be taken in fumigating tomato houses. Several trials were then made with two and one-half ounces for each thousand cubic feet of space and the results were similar. Some of the tomato plants were injured, but the insects were killed in all cases. One house which was old and not very tight allowed some of the fumes to escape, so that the plants were uninjured though the insects were all killed.

Dr. J. Fisher used one ounce of cyanide for each one thousand cubic feet of space and killed all the insects without injury to the tomato plants.†

Spraying.—In 1895, the writer used whale-oil soap solution (1 lb. of soap to 5 gallons of water) in the form of a spray on the under surface of the leaves to kill the nymphs. The result was successful, but on account of the disagreeable odor of whale-oil soap, it was discarded. Fir-tree oil (one-half pint in two gallons of water) gave excellent results when the plants were thoroughly sprayed with the solution. The adults and nymphs which were moistened by the spray were killed. The cost of the material, however, makes the treatment an expensive one and precludes its use on a large scale. Fir-tree oil has a pleasant odor and is not objectionable to use in a greenhouse of ornamental plants or even in a dwelling.

A fine spray of kerosene and water (15 per cent. kerosene) was then applied to the tomato plants on sunny days, by means of a "kerowater" pump, with good results in killing the insects.

* Bull. 81, Illinois Agr. Exp. Station, p. 512.

† Johnson, Fumigation Methods, p. 136.

But kerosene, like whale-oil soap, has an unpleasant odor, and occasionally causes a slight injury to the foliage. Even when not at first apparent, the leaves in some instances took on later a brown or reddish color not indicative of health, and some of these finally dropped.

Early in 1901, we began spraying the tomato plants with common soap and water, dissolving one pound of soap in eight gallons of water. This seemed to be the best, all things considered, of any of the sprays. Not only was it effectual in killing all adults and nymphs with which it came in contact, but it was both inexpensive and inodorous, and at first did not appear to cause the slightest injury to the plants. The soap was cut in thin slices, then dissolved in hot water, and cold water added to make the right proportions. The plants received one application each week for about three months, when some of the leaves finally exhibited signs of injury.

As the plants had never been sprinkled with water from the hose, and had received frequent applications of soap, the leaves finally became coated over with soap to such an extent as to seriously interfere with the normal processes of respiration. The lower leaves in some cases shriveled and dropped. A few sprayings cause no injury, and probably none would be done in any case if the plants are sprinkled freely with water to remove the excess of soap.

The chief difficulty with sprays of any kind is that it is impossible to reach all places where the insects are located. Many leaves are curled so that the spray cannot reach the under side, and there are always portions of plants which do not, on account of location perhaps, receive a thorough treatment; this permits the escape of a sufficient number of adults, or of nymphs which soon change to adults, to keep the house infected.

Summary.

1. The white-fly has been the worst insect pest of tomatoes and cucumbers under glass at the Station during the past eight years. Many florists' plants are also injured, and the insect has attacked strawberry and many other plants out of doors in summer. It has been received from several growers in Connecticut, and is widely distributed over the northeastern United States. Its original home is unknown.

2. The white-fly is closely related to the scale-insects, and to the plant lice. It resembles the former in its immature stages, but differs from it in that both sexes are winged when reaching the adult stage.

3. It injures plants by sucking the sap, from the under sides of the leaves. The lower leaves are the first to shrivel and drop. Most of the injury is caused by the nymphs or immature insects.

4. The nymphs of the white-fly have been found upon sixty different kinds of plants in Connecticut.

5. About five weeks are required for the white-fly to pass through its life-stages, all of which are found on the under sides of the leaves. Eggs hatch in eleven days, and the young nymphs crawl for a short time, when they become stationary and secrete wax in long filaments. When the adults emerge, the pupa skins remain attached to the leaves. It is not yet known whether the species can survive the winter unprotected in this climate, but it is carried over on plants in greenhouses and dwellings.

6. It is thought to be identical with the European species *A. vaporariorum* of Westwood, but this has not yet been fully determined.

7. Fumigating with tobacco is not an effective remedy. Hydrocyanic acid gas (using two and one-half ounces of potassium cyanide for each one thousand cubic feet) killed the insects but injured tomato plants. Dr. Fisher used one ounce of cyanide and did not injure his plants, but killed all of the insects.

8. Spraying the under surfaces of the leaves with common laundry soap and water (one pound dissolved in eight gallons) proved to be a cheap and effective remedy. If applied frequently, however, the soap should be occasionally washed from the leaves by spraying them with clear water.

INJURY TO TREES BY SQUIRRELS.

During 1901, and again in 1902 certain elm trees in New Haven were pruned of their twigs, which fell to the ground. It was thought to be the work of some insect—perhaps climbing cut-worms.

In May, 1902, it was observed to be the work of grey squirrels. The following note appeared in "Science" of June 13th, page 950, and is self-explanatory:

The Grey Squirrel as a Twig-Pruner.

"Last year my attention was called to some Elm street trees in New Haven, which had been injured by having the twigs eaten off early in June. The twigs were cut off through the hard wood formed the previous season, just below the new growth. Under certain trees the ground was fairly covered with the detached twigs. No borers were found in the severed portions as is the case when infested by the oak pruner, *Elaphidion villosum* Fabr., which attacks several kinds of shade tree. Still, it was supposed that some insect caused the damage, as climbing cut-worms sometimes eat off the new growth—but usually through the soft tissue.

The present season, similar injury has been reported from Farmington and New Haven.

On May 23, while cycling through the streets of New Haven, I noticed a small elm tree under which the ground was covered with freshly severed twigs. The same tree was attacked last year. Four grey squirrels were seen in the top busily engaged in devouring the nearly ripe seeds. As the seeds of the American elm are near the extremity of last season's growth where the twigs are very slender, the squirrels were obliged to perform many noteworthy acrobatic feats in order to obtain the seeds. Some were hanging by the hind feet from slender branches to reach twigs beneath them, and all were munching away at the seeds as if half starved. In some cases they were not able to reach the clusters of seeds, and would bite off the twigs, which dropped to the ground where they could find their food later. Several twigs were dropped in this way in a period of about two minutes, while the writer was watching them. In some cases the squirrels cut off twigs from which they had already eaten the seeds. Trees bearing no seeds are not pruned in this manner, and none of the trees will probably be injured very seriously. This habit of squirrels may have been recorded by other observers, but I do not remember seeing it in print.

The best remedy seems to be to provide the squirrels with plenty of other food at this season of the year when their natural food supply has been nearly exhausted.

W. E. Britton.
Conn. Agr. Experiment Station.

The gentleman who had reported a similar injury to trees in Farmington was informed of this discovery by the writer, and began to watch his own trees. Later he wrote that his trees too had "squirrels," but that they were red instead of grey squirrels. Some of the severed twigs are shown on Plate XII.

THE BROWN-TAIL MOTH.

Euproctis chrysorrhœa Linn..

Erroneously Reported from Hartford.

One of the leading daily papers of the State reported in its issue of May 16th:

"Specimens of the brown-tailed tussock moth were brought into the office yesterday, having been found in the northern section of the city. The moths have just hatched from the cocoon and, although very small, have already begun to weave their web, which resembles somewhat that of the tent caterpillar and nearly fills the glass jar in which they were received. They do not look to be dangerous, but are likely to grow into pests of substantial character. The specialty of the worm is tree foliage and it strips the leaves clean and is thus dreaded. In addition to its devastating qualities, it is said to be poisonous to human beings by reason of the white fluff of hairs which flies in the atmosphere and finds lodgement on the skin, producing an irritation resembling eczema. It is said that a great deal of money has been used in the vicinity of Boston during this season to destroy the cocoons and thus kill the little caterpillars before they had a chance to get into the world at all."

The writer immediately visited the office and examined the specimens referred to, which were not at all the brown-tail moth, but another species, the white-marked Tussock Moth, *Notolophus leucostigma* S. & A., which is fairly common throughout the State and which has been very destructive to shade trees in Boston, Brooklyn and other cities during the past few years. The newly hatched caterpillars were brought to the office accompanied by the statement that it was the brown-tail moth. The writer called attention to the error and the editor promised to correct it. Later several notes appeared in the same paper saying that specimens of the adult moths had been seen in Hartford by persons who were familiar with the insect in Massachusetts.

The brown-tail moth is not believed to be present in Connecticut, or at least its existence here has not been proved. But as it may be brought into the State at any time, from Massachusetts, everyone should be on the watch for it. Its identity should, however, be thoroughly established before announcing its presence. If specimens are sent to the State Entomologist, he will inform the sender whether or not it is the brown-tail moth and if it is will take prompt action to exterminate it.

In order that the reader may be more familiar with the appearance of this insect a brief account is given below.

The brown-tail moth is found in Southern and Central Europe, in Northern Africa and in Western Asia. It seems to have been brought from Europe to Massachusetts, where it was first noticed about ten years ago in the vicinity of Somerville. It was not known to be the brown-tail moth, however, until 1897,

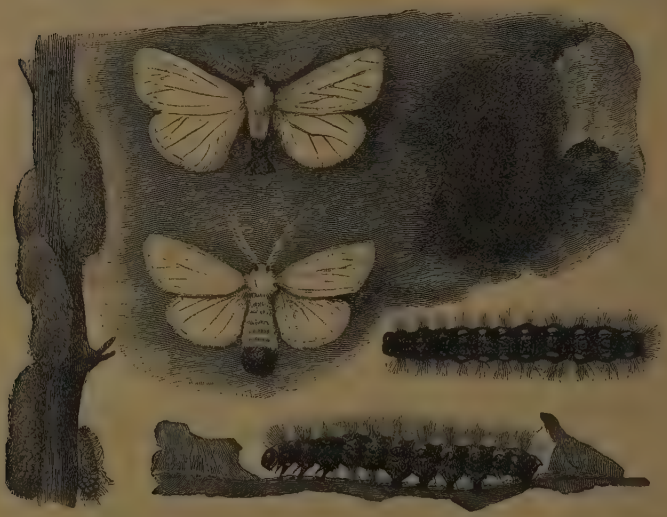


FIG. 11. The brown-tail moth *Emproctis chrysorrhea*, showing male moth above, female below, egg-masses at left, cocoon at right and caterpillars. (After Howard, Yearbook of U. S. Department of Agriculture for 1897.)

when the attention of the gypsy moth commission was called to the matter. It was made the subject of a bulletin* published in 1897 by the Massachusetts Agricultural Experiment Station at Amherst. Mr. A. H. Kirkland informs me that the brown-tail moth has now spread over an area of about 1,500 square miles, including portions of New Hampshire and Maine, as well as Eastern Massachusetts. Pear seems to be the chief food plant, but a list of thirty-six plants upon which the caterpillars were found feeding in Massachusetts, including our common fruit

* Special Bulletin, July, 1897.

and forest trees, is contained in the above-mentioned bulletin, from which was obtained most of the information about the insect herein given.

A good idea of the brown-tail moth in its different stages may be obtained from fig. 11. The eggs are laid on the under side of leaves in masses of 200 to 300, during the month of July. The young caterpillars begin feeding on the leaves, skeletonizing them, and soon form nests at the ends of the branches by drawing together leaves and fastening them with silken threads. In these nests the partially grown caterpillars pass the winter, coming out in the spring to feed upon the opening buds. A photograph of the winter nests is shown on Plate XIII.

When fully grown the caterpillars are about one and one-half inches in length, of a brown color with scattered reddish brown hairs. The body is marked with small grey spots. Along each side of the body there are long, white branched hairs that form elongated white spots arranged in a row.

When through feeding the caterpillars change to the pupa stage among the leaves. The pupa is three-fourths of an inch long and of a dark-brown color.

The hairs of the caterpillars cause an extreme irritation to the skin when brought in contact with it. The caterpillars frequently crawl about on houses and buildings in search of food and persons often brush against them.

The adult females are pure white, with a tuft of brown hairs on the end of the abdomen, and a wing expanse of about one and three-fourths inches. The males are smaller than the females, having a wing-expanse of about one and one-fourth inches, and there are small black dots on the fore wings. With the exception of these dots the male resembles the female, both of which are shown in figure 11.

THE RASPBERRY CANE MAGGOT.

Phorbia rubivora Coquillett.

During May injured raspberry canes were received from Bristol. Investigation showed the injury to have been caused by the cane maggot, a two-winged fly belonging to the genus *Phorbia,* and closely related to the onion maggot and cabbage maggot.

The insect has been reported from New York, Pennsylvania, West Virginia, Michigan and Canada. The females lay eggs on the young shoots in April when the latter are only a few inches high. The eggs soon hatch and the young maggot begins to tunnel downward in the pith, going about half the length of the shoot, then works its way out to the bark and cuts a tunnel around the stem, sometimes completely girdling it just under the bark. By this time the tip of the shoot begins to wilt, and a blackened area shows on the outside around the point of injury. The tip usually shrinks, droops over, and finally dries up and dies. The maggot eats a small hole through the bark from the girdle, though it does not emerge, but keeps on feeding in the pith until the shoot is nearly severed. The tunnel is shown in fig 12.

FIG. 12. Tunnel of cane maggot in raspberry shoot. Natural size.

The raspberry cane maggot has been studied in New York by Prof. Slingerland, and Bulletin 126 of the Cornell Agricultural Experiment Station contains an account of it.

At the time the bulletin was prepared the name of the insect had not been determined. Later it was found to be a new species and was described and named *Phorbia rubivora* by Mr. D. W. Coquillett of Washington, D. C. The technical description was published in Canadian Entomologist, Vol. XXIX, p. 162, July, 1897.

The maggots observed by Prof. Slingerland pupated about July 1st, but the adults did not emerge until the following April. The pupa stage is passed inside the tunnel near the base of the shoot, and the insect does not emerge from it until it comes forth as an adult fly.

The insect may do considerable damage in raspberry plantations, attacking both the red and black raspberries.

The only remedy is to cut out and burn the infested canes during May. Plate XIV shows the egg, adult fly and injured raspberry shoots.

CONTINUED DESTRUCTION OF HICKORY TREES BY THE HICKORY BARK BORER.

In my report of last year, page 267, was an account of serious injury to hickory trees in New Haven by the hickory bark borer *Scolytus quadrispinosus* Say:

The beetle has kept up the destruction through the season of 1902, and many more dead hickories have been removed. The attack has not been confined to the Hillhouse place, but trees to the north have been attacked, and hickories east of Whitney avenue have also been injured. During July Mr. Chas. E. Atwater of 321 Whitney avenue, after asking my advice, decided to spray the two hickory trees in his yard, and employed a local nursery firm fitted for spraying work to apply the poison. The nursery firm requested me to superintend the work, and on July 28th the spraying was done.

About nine pounds of arsenate of lead was prepared by dissolving arsenate of soda and acetate of lead and putting the two solutions together in a barrel holding between forty and fifty gallons, and filling up the barrel with water. The trees were thoroughly coated with this poisonous mixture from the ground to the twigs and foliage of the highest branches. It was thought that this might prevent the further eating of the twigs and also keep the beetles from breeding in the trunks if they had not already begun to do so. Twigs continued to fall, however, after applying the poison, though Mr. Atwater thinks that these were less numerous than before spraying. Possibly these twigs were nearly severed at the time of spraying and were broken off later.

Miss Hillhouse informs me that the dead trees that were cut out numbered about the same as last year. Probably not far from 250 hickory trees have been killed on the Hillhouse place by this beetle during the seasons of 1901 and 1902. (A few trees on this place were also sprayed, but I do not know what was used or the results.)

It is doubtful if spraying will prove a satisfactory remedy, and appearances now indicate that many more hickory trees in the vicinity may be killed unless the species should be held in check by its natural enemies.

THE COMMON CURRANT WORM.

Pteronus ribesii Scop. (*Nematus ventricosus* Klug.)

The chief enemy of the currant in Connecticut is the currant worm, usually called the imported currant worm because the species was introduced into America from Europe about 1858. It is now common all over the United States, while the native currant worm (*Pristiphora grossulariæ* Walsh) now seldom does much damage to cultivated berry plants in Connecticut.

The adults emerge from the ground and lay eggs on the under sides of the leaves during the latter part of April and in May.

FIG. 13. Eggs of the currant worm. Twice natural size.

This insect also attacks the gooseberry and the first eggs deposited are generally on gooseberry leaves because they unfold earlier than the currant leaves. The eggs are placed end to end in rows along the veins, as shown in fig. 13, on a gooseberry leaf. They are about one-twenty-fifth of an inch in length and slightly less than one-fifth of an inch in thickness.

They hatch within a week or ten days and the first larvæ were found feeding on May 8th at the Station last season. The newly hatched larvæ are whitish at first, but soon become green with black spots and a black head. Some partially grown specimens are shown in fig 14. Fig. 15 shows the appearance of the fully grown currant worm. The first and eleventh segments are tinged with yellow. During growth, which may require two or three weeks, the larva molts several times and finally reaches

a size of about three-fourths of an inch in length. It then descends to the ground and spins tough, smooth, brown cocoons in the soil near the surface and usually under the leaves and rubbish around the food-plants, which are often entirely de-

FIG. 14. The currant worm. Partially grown larvæ, twice natural size.

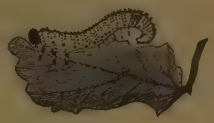


FIG. 15. Fully grown currant worm, natural size.

foliated. About the last of June or first of July the adults emerge, mate and the females lay eggs for the second brood. Cocoons are shown in fig. 16, and the adult female in fig. 17.

The adult is a four-winged fly and there is considerable difference between the sexes. The female is from one-fourth to

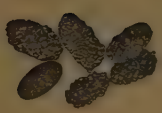


FIG. 16. Cocoons of currant worm. Natural size.

FIG. 17. Adult of the currant worm. Female, about twice natural size.

three-eighths of an inch in length, and has a yellow abdomen with head and thorax nearly black. The male is about one-fourth of an inch long and the general color of the body is black.

The second brood is usually small and produces cocoons that carry the species through the following winter.

The simplest remedial treatment is to apply hellebore to the leaves as soon as the young begin to feed. This may be dusted upon the plants in the form of a dry powder or may be mixed with water in the proportions of one ounce to two gallons of water. If applied as a powder, care must be taken to avoid inhaling it, as it is a very active irritant poison. Hellebore is peculiarly effective in destroying the currant worm and acts both as an internal poison and as an external irritant, often causing the worms to curl up and die as soon as the liquid is sprayed upon them. It is highly important that fresh hellebore be used, as the powder deteriorates after long standing. It is also important that the application be made early in the season as soon as the worms commence to feed and before the bushes have lost their leaves. Unquestionably the young are more easily destroyed than the full-grown larvæ, and it is usually necessary to go over the bushes a week or two after the first application, because the eggs do not all hatch at the same time, and as the plants are making a rapid leaf-growth at this season there are new leaves which have not been poisoned by the first treatment. If the first brood is kept well in check there will be little damage from the second. Many commercial growers use Paris green instead of hellebore, but in the home garden hellebore is preferable because it is not as dangerous a poison and is just as efficacious if fresh material is used and properly applied. The application should be repeated if washed off by heavy rains, provided any larvæ are eating the leaves. If Paris green is used with Bordeaux mixture it will stick upon the leaves for a long time, but even then the new leaves may need an application of poison. The currant worm is one of the easiest insects to control, if taken in season and the applications made with thoroughness.

THE ASPARAGUS BEETLE.

Crioceris asparagi Linn.

Asparagus plantations throughout the State are infested each season by the asparagus beetle. The adults appear in May and feed upon the new shoots. The eggs, laid about this time, hatch

in about eight days and the young larvæ or grubs feed upon the green tissue of the asparagus plants, especially upon the leaves and small stems. In about twelve days, or when fully grown, the grubs go into the ground and transform, the pupa stage lasting about ten days. Thus about thirty days are required to complete the life cycle of the asparagus beetle, and as there are several broods each season we find eggs, grubs and adults upon the plants from May until late in autumn. The winter is passed in the adult stage, the beetles seeking protected places under stones, rubbish and the rough bark of trees.

The asparagus beetle is a native of Europe and first became a serious pest in this country on Long Island in 1859, though probably introduced several years previously.

The eggs are brown in color, oval in shape and are nearly one-sixteenth of an inch in length. They are deposited in rows longitudinally on the shoot and each egg is set on end in a hole which has been eaten in the stem by the beetle. Occasionally an egg is placed on the end of another egg previously deposited.

The grubs or larvæ are a dull grey color with black head. The body is considerably thickened toward the posterior extremity. When fully grown they are nearly one-fourth of an inch in length. They then enter the ground or conceal themselves beneath dead leaves or rubbish and transform to pupæ in very simple cocoons. Ten days later the beetles emerge, thirty days having been required to complete the changes from the egg to the adult beetle.

The beetle is less than one-fourth of an inch in length. Head, legs and wing-covers are of a bright bluish black color. Thorax and margins of wing covers are of a light reddish brown. There are three cream-colored spots on each wing-cover, one at the base, the second just in front, near the center, and the third about half-way between the second and the tip of the wing cover. The first and second spots may be confluent, forming right-angled or L-shaped spots at the base of the wing covers.

The eggs, larva and beetle are shown on Plate XV.

Various remedies have been recommended against the asparagus beetle. After the cutting season is over the plants may be sprayed with Paris green or arsenate of lead. Air-slaked lime dusted on the plants when moist is frequently recommended.

In some fields it is the practice to allow trap shoots to grow and when well covered with eggs these are destroyed. During the past season we have had very good results at the Station in spraying young plants with hellebore—one ounce in two gallons of water.

MISCELLANEOUS INSECT NOTES.

Spinach Leaf-Miner.

Several fields of spinach plants in Greens Farms were found to be attacked by the spinach leaf-miner *Pegomyia vicina* Lintn. The growers in the vicinity were not familiar with the pest, though for several seasons it has been destructive on Long Island. It was also noticed in New Haven. The life history of the insect was worked out by Sirrine in 1895, and it was shown to have several (probably six) broods each season and to live in the wild goosefoot or lambs quarters (*Chenopodium*) and the foliage of beet. It becomes a serious pest, however, when it attacks spinach, as all the plants have to be examined and the infested leaves thrown out before the crop can be sent to market. The larvæ make at first a slender thread-like mine inside the leaf, but finally broaden the tunnel, which appears as a blotch upon the leaf, the green tissue having been devoured. The eggs are deposited on the lower surface of the leaf, and at no time in its life history is this insect amenable to the application of insecticides. Gathering and destroying infested leaves; crushing the maggots inside the leaf; fall plowing and keeping the fields free from weeds, especially lambs quarters, are recommended by Mr. Sirrine.*

The Twelve-spotted Asparagus Beetle in Connecticut.

This is an introduced species that has been gradually working northward. It has been present in New Jersey for several years. The writer has been on the watch for it in asparagus plantations in Connecticut, but has never found it. A single specimen was captured on asparagus in New Haven, June 16th, by a student who was collecting insects for the Station. We may fairly expect this species to continue northward, and to

* Bull. 99, N. S., N. Y. Agr. Exp. Station.

become established here as a pest of asparagus, injuring the plants in the same manner as the common asparagus beetle. The name of this new-comer is *Crioceris 12-punctata* Linn.

Orange-striped Oak-Worm and Spiny Oak-Worm.

During August many of the small oak trees about New Haven were stripped of their foliage by dark-brown spiny caterpillars with longitudinal orange stripes and a pair of fleshy black horn-like protuberances near the head. These caterpillars usually

FIG. 18. The orange-striped oak-worm. *Anisota senatoria.* Larva natural size.

feed in clusters, and if abundant, soon defoliate small trees. Smith states that he has seen acres of forest almost entirely defoliated by these caterpillars.* Doubtless the insect attacks the various species of oak, but here the black oak seemed to suffer more than other kinds. The orange-striped oak-worm, shown in fig. 18, is the larva of a yellowish brown moth called the Senator moth and bearing the scientific name of *Anisota senatoria* S. & A. Frequently we find associated with these striped caterpillars, another kind causing similar injury, but light yellowish brown in color, with black spines along the back and sides and the long black horn-like appendages near

* Economic Entomology, page 278.

the head. This is a closely related species, *Anisota stigma* Fabr., and is more abundant in the southern states.

Anomala binotata Gyll.

On May 8th some beetles were brought to the Station with the report that they had been feeding on strawberry leaves in a garden in New Haven. The leaves were considerably eaten, and over a hundred of the beetles were gathered and destroyed. The species proved to be *Anomala binotata* Gyll., and is shown in fig. 19. It is about half an inch in length with black head and

FIG. 19. *Anomala binotata.* About twice natural size.

thorax. Wing-covers are light brown with black markings. Antennæ light brown, and legs dark brown in color. Under side of thorax covered with light brown hairs. This beetle has been recorded as attacking the blossoms, but nowhere have I found any mention of injury to the leaves by it.

Some partially eaten leaves are shown on Plate XII.

Orange Dog Caterpillar—Papilio cresphontes Cram.

This insect was even more abundant in 1902 than during the preceding year. The caterpillars could be gathered by the hundred in some of the nurseries, where they were feeding upon the leaves of the "hop tree" *Ptelea trifoliata.*

Cedar Bark borers. Hylotrupes ligneus Fabr. *Callidium antennatum* Newm.

Specimens of *Hylotrupes ligneus* Fabr. were received in February from a correspondent in New Haven, who reported that the beetles emerged from cedar bean poles which had

been brought into a warm building. This beetle is about one-third of an inch long with light-brown wing-covers marked with black; a large spot occurring near the center of each wing-cover and the distal third black. This beetle is a serious enemy of the cedar tree in some localities.

The second species is of nearly the same size and shape as *Hylotrupes*, but is of a metallic blue or green in color with no markings. A great many of these beetles emerged from a dozen cedar bean poles in the writer's garden in May, and nearly a hundred were captured.

Saw-fly on Birch.

During the fall several young birch trees on the Station grounds were partially stripped of their foliage by saw-fly larvæ, and had these trees not been sprayed every leaf would have been devoured. Paper birch and red birch were the kinds attacked. The larvæ were gregarious and devoured the leaves rapidly. The adults were not obtained or the insect identified, but it probably belongs to the genus *Nematus*. The larva is about seven-eighths of an inch long and of a yellowish green color with a row of black or brown patches along each side of the body. Head and feet are black and prolegs white.

Some of the trees were sprayed with hellebore—one ounce in two gallons of water, and others with soap—one pound in eight gallons of water. Both remedies were effective in destroying the insects.

Lagoa crispata Pack.

The caterpillar of the Crinkled Flannel Moth *Lagoa crispata* Pack. was unusually abundant during August and September, and was found feeding upon the leaves of apple, quince, chestnut and hickory. It is a curious slug-like larva, covered with brown hairs, shown on Plate XV. The adult is a beautiful light yellow moth with brown wavy markings, from which the common name is taken. It will probably never be sufficiently abundant to be much of a pest.

The Cherry-Scale in Connecticut.

The cherry-scale *Aspidiotus forbesi* John. during February was found on apple cions taken from a tree in Bristol. The

locality has not yet been examined, but the species has probably become established in the State. The same treatment recommended for San José scale-insect should be employed to destroy the cherry-scale.

ILLUSTRATIONS.

The illustrations in this report are from the following sources:

Plate XIV is herein reproduced from Bulletin 126 of the Cornell Agr. Exp. Station, by courtesy of Prof. M. V. Slingerland, Entomologist.

Plates VIII to XI and XV, a, b, and c, are from photographs made for the author by the late Mr. H. A. Doty.

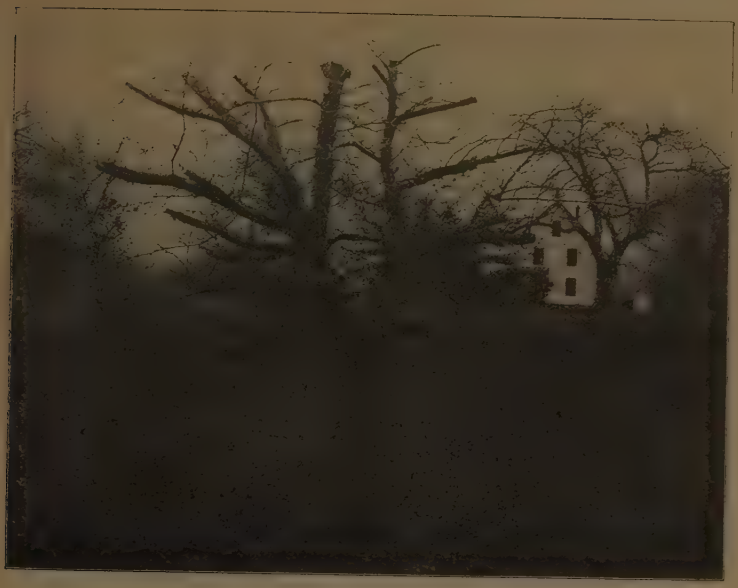
Plates II to VII, XII, XIII and XV, d, are from photographs made by Mr. B. H. Walden, under the author's direction.

Plate I is from a photograph by the author.

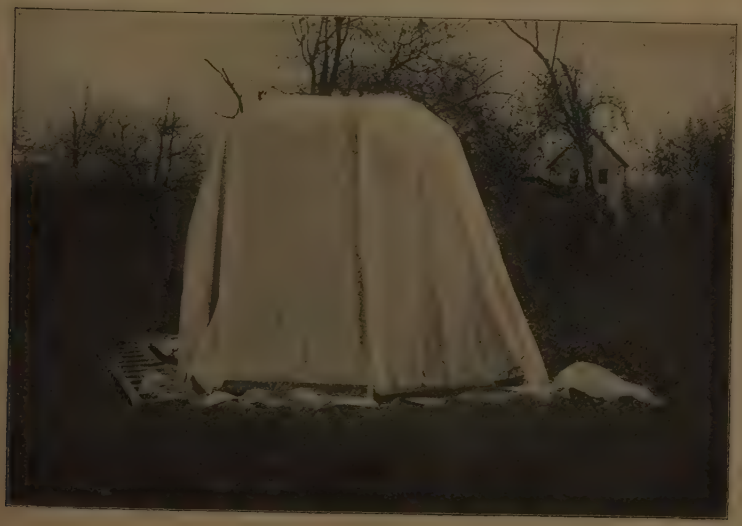
Figures 2 and 11 are from publications of the Division of Entomology, U. S. Department of Agriculture, by courtesy of Dr. L. O. Howard, Entomologist. Figures 3, 13, 14, and 16 were made and engraved on wood from photographs and specimens, by Mr. R. M. Sherman, who also made figures 15, 17 and 18 from drawings by Mr. Walden, and figures 2, 6 to 10, 12 and 19 from drawings by the author. Figures 4 and 5 were etched on zinc from sketches by the author.

PLATE I.

Trees killed by San José Scale and "Yellows." View in a Connecticut Peach Orchard.



a. Tree cut back ready for treatment.



b. Tree covered by tent.

FUMIGATING LARGE TREES.

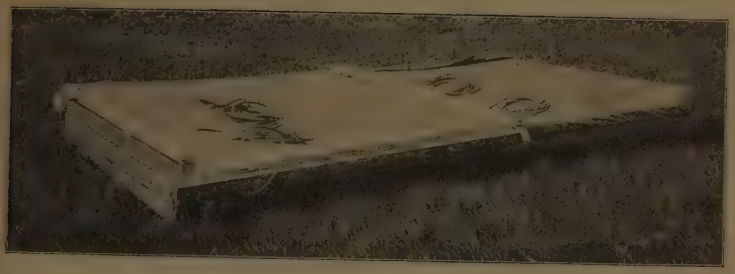
I.
E.

a. Barnes Bros. plant for boiling the lime, sulphur and salt mixture.

b. Fumigating box for small plants, cions, buds, etc.

c. A fungus attacking the San José scale forms black spots on the twigs. Natural size.

FUNGUS: FUMIGATING BOX: STEAM PLANT FOR COOKING THE LIME, SULPHUR AND SALT MIXTURE.

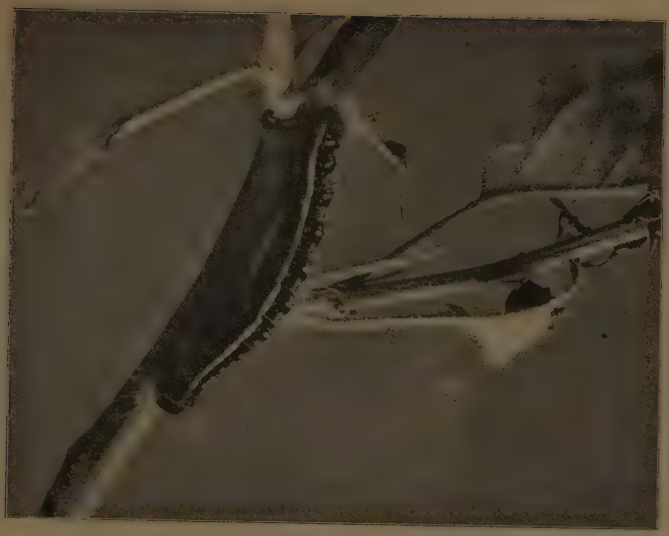


a. The tent folded.

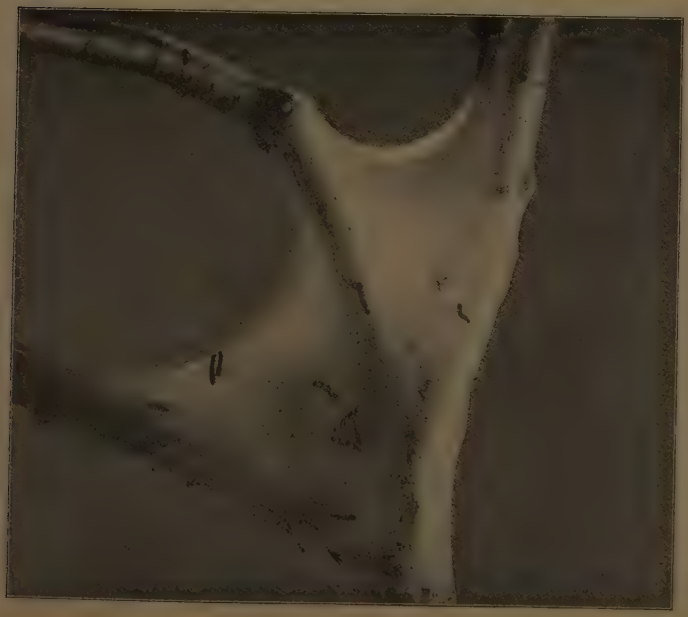
b. The tent over a tree.

FOLDING TENT FOR FUMIGATING TREES.

I. B.
E.

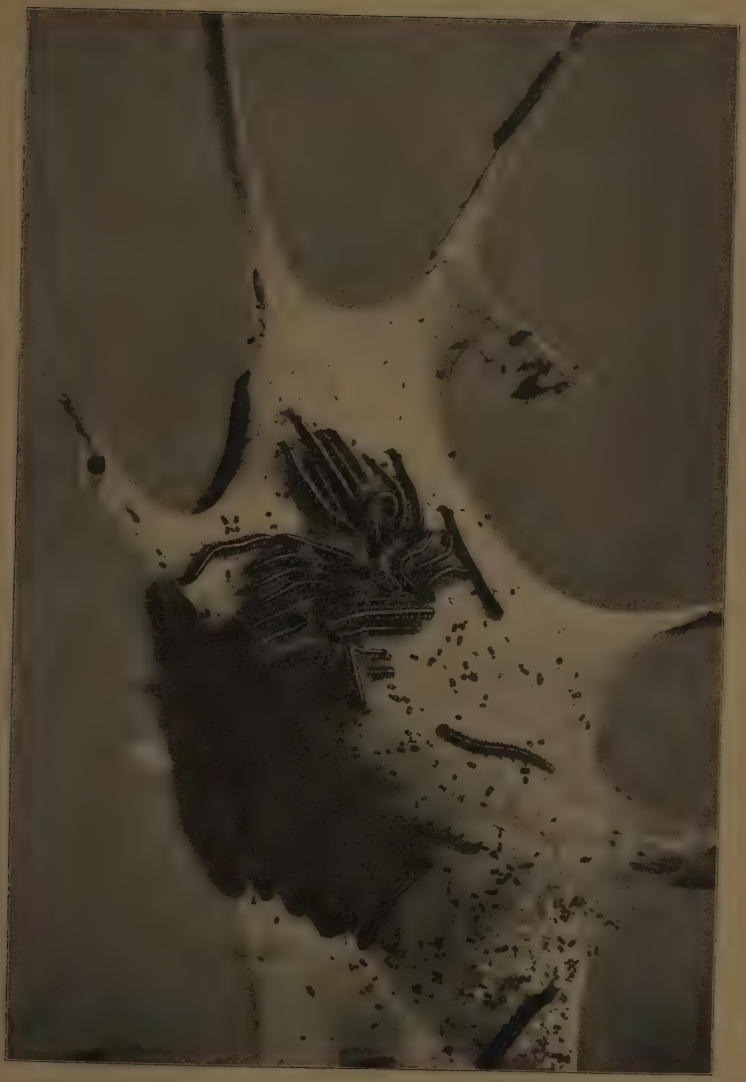


a. A full-grown Caterpillar. Natural size.



b. Young Caterpillars in nest.

I. F.
E.



Caterpillars resting on the outside of the nest.

THE TENT-CATERPILLAR.

L. B.
E.

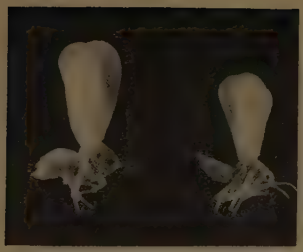
a. Male and female moths. Natural size.

b. Cocoons of the Tent-Caterpillar. Natural size.

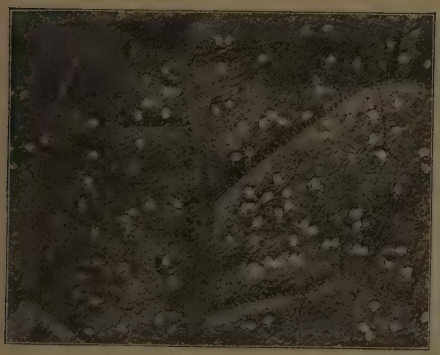
a. Nymphs: Enlarged about four times.

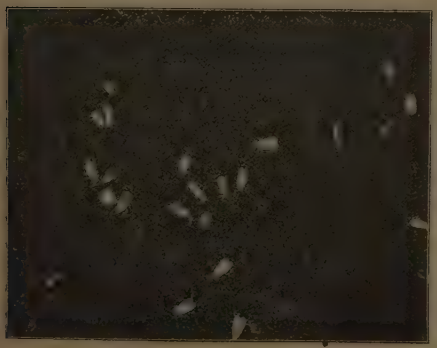
b. Adults and pupa skins. Enlarged four times.

THE WHITE-FLY ON TOBACCO LEAF.

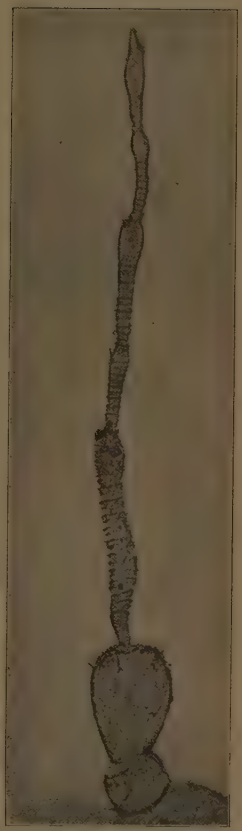


a. Female and male: much enlarged.





b. Nymphs and adults; twice natural size.



c. Antenna, showing ring-like markings: much enlarged.

THE WHITE-FLY.

I. H.
E.

a. Egg, showing stalk : much enlarged.

b. Adult female, ventral view, showing proboscis : much enlarged.

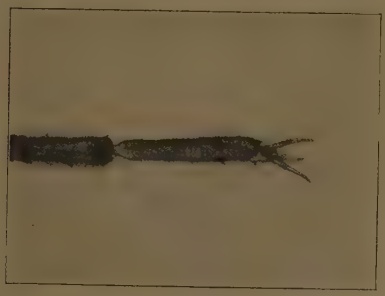
c. Genital organs of male : much enlarged.

d. Ovipositor of female : much enlarged.

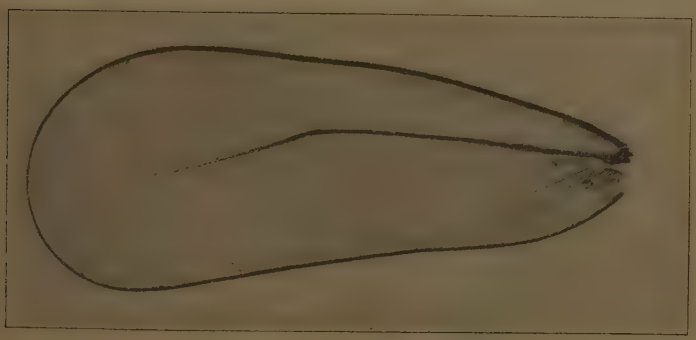
THE WHITE-FLY.

I B.
E.

a. Edge of wing: much enlarged.



c. Foot: greatly enlarged.



b. Fore wing: greatly enlarged.

THE WHITE-FLY.

I. B.
E.

a. Elm twigs cut off by Grey Squirrels.

b. Strawberry leaves eaten by *Anomala binotata* Gyll.

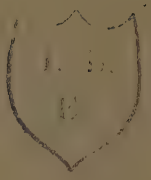
ELM TWIGS AND STRAWBERRY LEAVES.

I. B.
E.

Winter nests of the Brown-Tail Moth. Natural size.

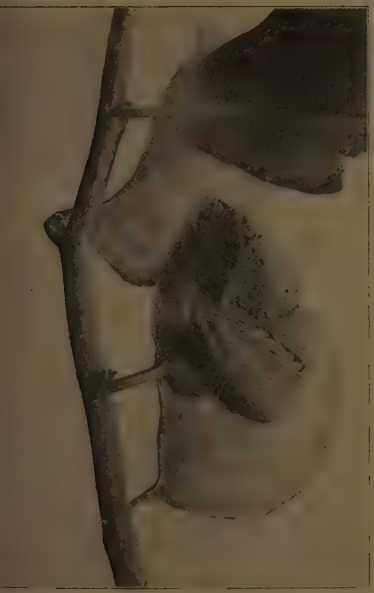
a. Adult female fly, much enlarged; b. Raspberry shoots injured by the maggot, natural size; c. Egg, much enlarged; d. Tips of shoots, each bearing an egg, natural size (after Slingerland, Cornell University Experiment Station, Bulletin 126).

THE RASPBERRY CANE MAGGOT.



b. Larva of asparagus beetle. Much enlarged.

c. Asparagus beetle. Much enlarged.



d. Larva of the crinkled Flannel moth *Lagoa crispata*. Natural size.

a. Eggs of asparagus beetle. Much enlarged.

LAGOA CRISPATA AND THE ASPARAGUS BEETLE.

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